C. L. MADSEN

THERMO-GEOGRAPHICAL STUDIES

GENERAL EXPOSITION OF THE ANALYTICAL METHOD APPLIED TO RESEARCHES ON TEMPERATURE AND CLIMATE

AWARDED BY THE SMITHSONIAN INSTITUTION, WASHINGTON, WITH THE HODGKINS MEDAL, 1895

WITH NUMEROUS TABLES AND PLANS

AND

A CODIFICATION OF THE PRINCIPAL THERMO-GEOGRAPHICAL FORMULÆ, TABLES AND DEFINITIONS

PUBLISHED AT THE EXPENSES OF „CARLSBERGFONDET", COPENHAGEN

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RESEARCHES ON TEMPERATURE AND CLIMATE

A number of essays have formerly been published by the same Author, partly relating to certain projects and improvements in defensive warfare, and partly to researches and proposals concerning international communications.

Of the last class only the following may here be named:

Recherches sur la loi du mouvement télégraphique international. 1877. (Published at the request of „National-økonomisk Forening", Copenhagen).

Lectures and essays on the theory of the international telegraph traffic as a function of the international, chiefly commercial intercourse. (Journal of the Royal Danish Geographical Society, Meeting of scandinavian naturalists &c. &c.). 1876—82.

Researches on the traffic and relations between the scandinavian and foreign countries. 1879. 1880.

The North - Atlantic Telegraph over the Fœrøe Isles, Iceland and Greenland. With plan and table. 1882.

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Articles on the subject of Thermo-Geography will be most thankfully received; senders are respectfully invited to forward publications, intended for the Author of the studies, to the care of Mr. G. E. C. Gad, Bookseller for the University, Copenhagen, Denmark.

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INTRODUCTION.

> Die physische Geographie hat ihre numerischen Elemente wie das Weltsystem, und wir werden in der Kenntniss dieser Elemente in dem Maasse fortschreiten, als wir die Thatsachen besser benutzen lernen, um in ihnen die allgemeinen Gesetze mitten in dem Zusammenwirken der partiellen Störungen zu erkennen.
>
> ALEXANDER VON HUMBOLDT.

The above quoted weighty and suggestive words of the eminent and energic promoter of the science of nature, and the problems thus set forth, are in all their bearings perhaps nowhere more appropriate than in connection with attempts to solve, analytically, the entire **thermo-geographical problem.** The proper equations and formulæ for determining the normal mean yearly and monthly temperature of a place are evidently to be composed of a multitude of factors, among which, besides the geographical position, those representing the configuration, the dynamic and physical properties of the earths surface take a marked position. The analytical method, applied to thermo-geographical researches, opens, therefore, a wide perspective for the study of the physical geography, and, in time, for the determination of the exact relationship between the over-important factors in organic life: the temperature on the one side, and the effect of the sun, of the earths motion and of the earths surface, or generally the geo-physical elements, on the other side. There can be no doubt, that progress will be made and that such are certain to follow in the same order as the numerical equations, forming the connecting link between cosmical and geo-physical factors, are gaining ground and codified for further investigations and studies.

The thermo-geographical problem, when taken in its full extent, does not only include the analytical determination of the normal mean yearly temperature of a place, the geographical position of which is given, but also of the annual movement in temperature, defined by the corresponding normal mean monthly temperature of the place concerned. But although the elements required for carrying out the complete program may be pointed out, and, moreover, although the temperature, the most important of the meteorological elements, and which forms the principal foundation of all meteorological sciences*), is known in general to depend on the geographical position, a system of thermo-geographical equations and formulæ, adapted for practical use and capable of perfection, is still wanted. This state of the problem before us is illustrated and to a certain extent explained by the fact, that most of the handbooks of meteorology and cosmical physic do not give any information about the attempts made in regard to this point; tables of temperature are seldom seen, and even important contributions and works on the subject are often left unnoticed or disposed of with a discouraging remark on the „inconvenience in the application of such formulæ“ **). In consequence

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*) „The distribution of temperature in atmosphere may be regarded as the fundamental problem of meteorology, seeing that the varying pressures, humidities, and winds are either direct or indirect consequences of the varying distribution of temperature.“ — Reports on the scientific results of the voyage of H. M. S. Challenger, 1873—76. Prepared under the Superintendence of *John Murray,* L L D, Ph. D. &c. Vol. II. Part V. Report on atmospheric circulation. By *Alexander Buchan,* M. A., L L D. London, 1889.

**) It must certainly be admitted, that *Schochs* formula for the mean yearly temperature (Réaumur) of a place, the geographical longitude and latitude of which is given, is a rather complicated one, as will appear from the formula:

$$
\begin{aligned}
T\varphi, \vartheta = {} & 12{,}_{03} + 0{,}_{16}\cos\vartheta - 31{,}_{63}(\cos^2\vartheta - {}^1/_3) - 0{,}_1(\cos^3\vartheta - {}^3/_5\cos\vartheta) \\
& + \sin\vartheta \begin{cases} \cos\varphi\,[0{,}_{36} + 2{,}_{61}\cos\vartheta + 0{,}_{03}(\cos^2\vartheta - {}^1/_5)\,] \\ \sin\varphi\,[0{,}_{25} - 0{,}_{51}\cos\vartheta + 0{,}_{01}(\cos^2\vartheta - {}^1/_5)\,] \end{cases} \\
& + \sin^2\vartheta\,[\cos 2\varphi\,(0{,}_{25} + 1{,}_6\cos\vartheta) + \sin 2\varphi\,(0{,}_3 + 1{,}_{24}\cos\vartheta)\,] \\
& - 0{,}_{68}\sin^3\vartheta\cos 3\varphi.
\end{aligned}
$$

In this formula the longitude (φ) is reckoned from the Greenwich Meridian round the earth (360°), while the geographical latitude in a similar unusual manner is represented by (ϑ), the complement of the actual latitude. — On the representation of the mean yearly temperature of a place as a function of its geographical longitude and latitude. — Inaugural dissertation for the degree of Ph. D. at the University of Zürich, August 9, 1856. By *Wilhelm Schoch.* — Translated with an introduction by *Frank Waldo.* Ann Arbor, Michigan, 1891.

of these and similar observations from competent parts, the present Author has been anxious to realize the utmost simplification of the equations and formulæ, and at the same time to ensure a correctness in the results, which will compare favorably with statistics furnished in reliable works.

In strict compliance with the principles and methods adopted by the Author, which in many respects differ from those followed in other attempts to solve the problem, only authentic numericals, statistically confirmed, are used as fundaments for the construction of the obtained equations and formulæ; consequently, all the analytical operations move on the surface of the earth itself, i. e. at the bottom of the atmosphere, and functions of a more speculative, uncertain and partly hypothetical nature are therefore excluded from the equations. This mode of dealing with the subject appears all the more justified by the present state of meteorological records, as the generally available observations not yet do include periods of sufficient duration to warrant an exact standard for the normal mean yearly (and monthly) temperature, with which the precision of analytical proceedings and of the formulæ themselves can be measured. From the results obtained it is, however, evident, that the coefficients and factors, as well as the composition of the formulæ, as a rule are in a most satisfactory accordance with actual observations; it is therefore but natural to conclude, that the main functions thus adopted correctly represent the powers at work in the thermal process on that part of the earths surface, which, as far as the mean yearly temperature of a place is concerned, has been selected by the Author as basis for these studies. This part includes the Atlantic middle-zones, extending over one-half of the Northern Hemisphere (from 90^0 W. to 90^0 E.), where the thermal phenomena are more complicated than in any other part of the world; similar or even more satisfactory results will therefore doubtless be obtained, when the same method and principles are employed in researches, covering the remaining parts of the Globes surface. — Previous to the above, the special and more difficile part of the problem, the general formulæ for determining the normal mean yearly temperature of the Northern and Southern Parallels (the solar climate) were constructed and derived by means of repeated applications of the method of least squares to numerical statements, given by different Authors and Equations (§ 1—4).

In the above observations it is stated, that the Author in a limitation of the geographical domain has seen the principal condition for obtaining such special *„Formulæ for the Year“*, which will combine precision in the results with a moderate complication. A further simplification and accuracy is obtained by the selection of the variable terms, and the formulæ for these terms were finally determined by the method of least squares applied to fundamental quantities, derived from an extensive numerical transformation and correction of Prof. *Jul. Hann's* system of Isothermals for the Year, as published in „Atlas der Meteorologie“, 1887, (Part II).

In connection with the above remarks it should be noted, that the division of the selected part of the Northern Hemisphere for certain geographical and analytical reasons has been carried still further, particularly by means of the Parallel 50°, the Greenwich Meridian and the Meridians of 90° and 50°, West and East. This plan affords in the points of coincidence some characteristic means of control, not attainable in more generalized proceedings, and of great importance for future corrections of the formulæ*) (§ 16).

The *„Formulæ for the Months“*, constructed on different principles, are at present composed of the mean yearly temperature of the place in addition to certain dynamo-cosmical terms combined with an annual coefficient, derived respectively from the Greenwich Ephemerides for 1891 and 1892 and from actually observed series of temperature. The former terms correspond to the *„solar year“* and to the *„retarded“* position of the sun, referred to the chronological centre of each month, the latter coefficient mainly represents the continentality (the climate) of the place. — The cosmical terms for determining the normal mean monthly temperature are in principle the same for any given geographical position, but of course the numericals assume a different

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*) The following example shows the effect of this plan. In the point lat. 50° and long. 50° W. we have

the calculated mean yearly temperature, derived from the co-operating equations	+ 4,762	5,476	4,943	5,669	°C
means of the calculated temperature	+ 5,213	°C			
the temp. at this point, accord. to the corrected isothermals . .	+ 5,370	°C			
difference	— 0,157	°C			

The London—Greenwich series of temperature (Tab. IX, 20) represent another class of examples.

value for the Northern and Southern, temperate and polar zones, and are by special formulæ determined for places, situated within the tropical zone.

The formulæ for the months, when applied to any observed temperature for the year, generally leave a difference from the observed monthly series of temperature of the place. This series of differences, composed of positive and negative terms, the sum of which = 0, is termed *„the meteorological series“;* a close examination and comparison of these series for long periods will no doubt present many points of considerable interest, and further the development of the thermo-geographical formulæ for the year as well as for the months, more especially for certain tropical regions with „continuous series“ (the Monsoon districts of India, § 58).

„The thermal order of the Months“ is another feature, which in connection with the meteorological series will offer to the Meteorologist an easily applicable criterion for the thermal classification of the meteorological elements. The successive change in the thermal order of the months, taking place in the transit from the Northern to the Southern Hemisphere (more prominently represented in Tab. X), compared to observations on the displacement, in both hemispheres increasing towards the Equator, discloses a point of great interest for meteorological investigations, and confirms at the same time the analytical expression for the „retardation“, in the general thermal process caused by the phenomenon of absorption (§ 20).

From the above observations it will be seen, that besides the analytical requirements in regard to the practical use and accuracy of the formulæ, another principle has been realized, to viz., that of distinguishing in the equations and formulæ (for the year as well as for the months) between factors of cosmical nature, and those due to the thermal action of the surface itself (conveyance of heat), and therefore in these researches given the name of thermo-geographical functions. The complete system of equations is accordingly divided in two groups of factors representing respectively the regularly and irregularly working powers, or the fundamental (cosmical) and constant factors, and the supplementary (geo-physical) and varying factors. The consequences of this plan are particularly of importance for the support, which the application of the analytical method in researches relating to the physical Geography probably may find in systematically arranged, numerical representations of the leading features in the

construction of the globes surface in respect to the present thermal condition of the same (Part V and VIII, Plan I).

In the studies the Author has endeavoured fully to expose the arguments, which in the progress of the work have proved decisive for the plan followed in the analytical proceedings, and by exhaustive evidences to prove the correctness of the final conclusions and numerical results. — The question of stability of the cosmical factors has, for inst., been repeatedly discussed and proved, and a series of applications and reflections closely follow the progressive analytical treatment of the subject. But above all the Author has been anxious numerically to demonstrate the degree of accuracy obtained in the working of the equations by extensive comparisons to the statistical fundaments and to the general statistics of actual observations of the mean yearly and monthly temperature. The statistical data, used for this purpose, are chiefly taken from the already named *„Challenger Reports on atmospheric circulation“*, and completed by data from Doves tables and other authentic and recent publications. — In addition to the numerical researches and proofs, the conformity of the analytical expressions to the geographical conditions has been followed throughout with special attention. It is a matter of course, that the Atlantic Ocean, its shores and islands, and the Gulf stream form the central object in the geographical reflections, which may assist in completing the sphere of applications and widen the prospects for special researches, founded upon the established numerical relationship of the thermal and geo-physical conditions and observations.

In support of the above considerations a few of the numerous facts brought to light and fully dealt with in the treatise may here be mentioned.

Thus the presence in almost the theoretical value of the Constant $\Sigma\,(+\,Q_m) = 3{,}_{8874}$ in all series of temperature from the northern, temperate and polar zones*), demonstrates in a surprising manner Humboldts idea of fundamental numerical elements in the physical geography. The following details may be of interest. According to numerous actual observations the term $\Sigma\,(+\,Q_m)$, founded upon the action of cosmical

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*) The corresponding figure for the southern hemisphere is calculated to $3{,}_{6322}$ and for the tropical zone determined by special formulæ.

and terrestrial phenomena (§ 20), takes a statistical value*) in different Continents and Oceans as follows:

Europe	$3,_{7279}$
Asia	$3,_{9011}$
The North-Atlantic	$3,_{9341}$
North-America	$3,_{9047}$

The mean value of 446 series is equal to $3,_{8660}$, or $= 99,_{45}$, if the theoretical value be $= 100,_{00}$.

The thermo-geographical coefficient *MV* (§ 27) is another important function, the very simple relation of which to the distance from the deep oceans renders the same particularly well adapted for precise examinations of the geographical situation; this factor is investigated in details in § 44—45 (coefficients along different parallels and especially that of 50° N., Pl. II and III), in § 28 (coefficients round the Caspian sea) and, in regard to height over the open sea, in § 48.

The interesting case of Bukharest (§ 40) shows the effect of the annual thermo-geographical component as a controlling instrument, by means of which it may be possible to substantiate any irregularity in the observed mean yearly temperature. It is evident, that this effect is due to the exact determination of the normal mean yearly temperature of the parallels (§ 1—4).

The proposed numerical classification of the climate by means of the coefficient *MV* (§ 30) and the thermal classification of the months by means of the dynamo-cosmical factor Q_m (§ 51) illustrate again, together with the introduction of the meteorological series (§ 55), the general use, that can be made of the numerical elements in important geo-physical researches.

Of other moments of interest in respect to the physical condition of the Globes surface may be named the mean temperature of the different zones and of the hemi-

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*) Particularly referring to the statistical value of the term $\Sigma\,(+\,Q_m^1)$, the necessity of raising the exactness of the usually employed average method is proved by the analysis of *Renous* 120-years series of the temperature of Paris (§ 21). Means given with one dec. only leave the value of this term $= 3,_{8580}$, but with two dec. the series give the almost theoretical value $= 3,_{8804}$.

This instance together with the Francfort experiment (§ 35) point direct to the frequently mentioned consequences of the absolute absence of standard figures, characteristic for meteorological statistics.

pheres, which now can be analytically determined, as shown in Part I. The determination of the Parallels of equal latitude and temperature (48° 49′ N. and S., + 7,225 °C) has, besides, been of importance for the plan followed in these researches.

The above references to certain branches of the application of the analytical method may suffice for the purpose; but it also deserves mentioning, that results of considerable interest for inquiries in other regions may be derived from the formulæ, as has been shown in part I, § 5 and 7.

The constant mean temperature of the earths surface, for inst., is according to the present researches (§ 5) calculated to + 15,3 °C, while the temperature given by Dr. Schoch, as result from his formulæ, is equal to + 15,0 °C; this striking accordance, still more remarkable because the fundaments for the calculation are entirely different, reflects upon this important quantity a high degree of probability. Now it is obvious, that the constant temperature of the globes surface, thus stated, corresponds to a uniform constant temperature, equal to + 61 °C, of a sphere of physical constitution equal to the surface of the earth, and placed in the earths mean distance from the sun. Starting from this planetary temperature the solar temperature (in the immediate proximity of the sun) may be calculated as a minimum to about $2^3/_4$ millions of degrees Centigrade (§ 7). In view of the attempts, mentioned in § 7, to form an idea of the immense quantity of heat constantly emanating from the sun*), the above temperature, as originally founded upon actual observations, may be taken as an acceptable approximation to at least that limit, below which any statement of the suns temperature appears rather improbable.

The numerous tables and plans accompanying the treatise are constructed and completed in order to afford the means of more minute comparisons, and to serve as evidences of the registered results.

A Codification of the principal thermo-geographical formulæ, tables and definitions will be found under part IX; as appendix to § 36 is further given, as example, a complete specimen of the analytical operations required for the determination of the normal mean yearly and monthly temperature of New-York.

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*) 450 millions degrees Centigrade and 3000 to 1500 °C indicate the extreme statements on the temperature of the sun.

The general result of the completed work may be expressed in the conclusion (§ 63 and 70):

that the codified system of thermo-geographical formulæ, including corrections for certain extreme regions, produces results, approximating the means of many years of actual observations, and

that the same opens a new field for analytical investigations in the physical geography, based upon the temperature as a standard-unit for the measurement and comparison of geo-physical and meteorological elements.

Special and comparative investigations on the distribution of temperature in high latitudes over the Northern Atlantic, its islands and boundaries, and on the principal cause of changes in the temperature of this region, are in course of completion. Several contributions have for this purpose been received from Professor *John Murray* of the Challenger expedition, and collected from publications by the Smithsonian Institution and the central Meteorological Institutes of Copenhagen, Christiania and Hamburg. —

The *Additional studies on the temperature of places in arctic regions* (Part VII) contain such improvements of the thermo-geographical formulæ and methods as are obtained by the continued investigations until 1896; the formation of arctic tables of temperature, the introduction of a method for completing interrupted series of observations, and for the calculatory determination of the thermo-geographical coefficient may be specially named. The calculated temperature at Nansens Point (86° 14′ lat. N. and 90° long. E.), when compared to the observations of temperature, taken during Dr. *Fridtjof Nansens* most successful polar expedition 1893—96 but not yet published, will doubtless offer ample means for renewed researches, and eventually for correction of the arctic methods ard tables, given in Part VII and in the Codification as an introduction to more complete researches. Practical proposals may possibly issue from continued studies on the question of arctic and north-atlantic temperature and on the cause of oscillations in the same.

Tables for interpolating the normal mean yearly temperature of the parallels of any latitude, and the annual thermo-geographical component of places in the Atlantic middle-zones, have recently (1897) been prepared and are included in the Codification,

thus marking one step further in the efforts for simplifying the analytical operations, without incurring any particular risk in regard to the required precision.

The preparatory studies on the thermo-geographical problem were commenced early in 1890, several years before the Circular of March 31, 1893, announcing the first competition for the Hodgkins Fund Prizes, was issued by the *Smithsonian Institution, Washington;* the work was at that time so far advanced, that the main parts with appendices were completed and presented to the Institution on the 1st of June 1894 and the supplementary parts with tables the year after. — The adjoining notes from the Committees Report of August 9, 1895, and the abstract of a letter of October 26, 1895, from Dr. *S. P. Langley,* Secretary of the Smithsonian Institution and Chairman ex-officio of the appointed Hodgkins Committee, relate to the results of the competition as far as the „Thermo-Geographical Studies“ are concerned.

In concluding I feel bound to express at this place my sincere thanks to the Director of Deutsche Seewarte, Hamburg, Professor, Dr. *G. Neumayer,* with which authority I had the advantage at an early period to discuss several important points, and who ever since gave his invaluable aid in following and showing his deep interest in the progress of the long-lasting work.

And sincere thanks are also due to the Board of Directors of *„Carlsberg-fondet“*, Copenhagen, whose liberal donation secured the publication in extenso, thus including the collection of tables and graphical representations, which may be found useful for continued studies on the thermo-geographical problem.

Copenhagen, April 1897.

C. L. Madsen.

NOTES FROM THE REPORT OF THE COMMITTEE APPOINTED BY THE SMITHSONIAN INSTITUTION TO AWARD THE HODGKINS FUND PRIZES.

(Dated Washington, August 9, 1895.)

1. The Committee was composed of the following members:
   Doctor *S. P. Langley*, chairman, ex-officio; Doctor *G. Brown Goode*, appointed by the Secretary of the Smithsonian Institution; Assistant-Surgeon-General *John S. Billings*, by the President of the National Academy of Sciences; Professor *M. W. Harrington*, by the President of the American Association for the Advancement of Science.

2. The Foreign Advisory Committee, as first constituted, was represented by Monsieur *J. Janssen*, Professor *T. H. Huxley*, and Professor *von Helmholtz:* and after the recent loss of the latter, Doctor *W. von Bezold* was added.

3. In consequence of the Circular of March 31, 1893, two hundred and eighteen papers were submitted to and examined by the Committee.

4. First prize, of ten thousand dollars, for a treatise embodying some new and important discoveries in regard to the nature or properties of atmospheric air, to Lord *Rayleigh*, of London, and Professor *William Ramsay*, of the University College, London, for the discovery of *Argon*, a new element of the atmosphere.
   The second prize, of two thousand dollars, was not awarded.
   The third prize, of one thousand dollars, to Doctor *Henry de Varigny*, of Paris, for the best popular treatise upon atmospheric air, its properties and relationships.

5. Supplementary Report. After having performed the function to which the Committee was called, as announced by the Circular of the Secretary of the Smithsonian Institution, dated March 31, 1893, which function did not include the award of any medals, — — The Committee has decided that honorable mention should be made of the papers, twenty-one in number, included in the following list, which also gives the full names, titles and adresses of the authors and the mottoes or pseudonyms which in four instances were employed. To three of the papers a silver medal is awarded, and to six a bronze medal:

HONORABLE MENTION WITH SILVER MEDAL.

Professor *A. L. Herrera* and Doctor *Vergara Lopez*, of the City of Mexico.
„La Atmosfera de las altitudes y el bienstar del hombre.“

Mr. *C. L. Madsen*, — „Geo“, — Helsingør, near Copenhagen, Denmark.
„Thermo-geographical studies.“

Mr. *F. A. R. Russell*, of London, Vice President of the Royal Meteorological Society of great Britain.
„The atmosphere in relation to human life and health.“

ABSTRACT OF A LETTER, DATED WASHINGTON, OCTOBER 26, 1895.

SMITHSONIAN INSTITUTION.

SIR,

Having now received the final report of the „Committee on Award of the Hodgkins Prizes", announced in a circular issued by the Smithsonian Institution on March 31, 1893, I have the honor to enclose herewith a copy of the Committees report of August 9, 1895, in which, with the advice and concurrence of the Foreign Advisory Committee, a decision was announced with regard to the several prizes offered.

The result of the competition, which was at once made known through the scientific journals, being now finally communicated to you, I desire to say that after the award of the prizes announced in the circular there remained certain memoirs which appeared to the Comitee of such merit that they represented to the Institution the desirability that they should be specially acknowledged. It affords me much pleasure to announce, in confirmation of the printed statement, that your memoir entitled, „Thermo-Geographical Studies", is one whose exceptional merit has been thus recognized and has been designated by the subsequent award of an Honorable Mention with a Silver Medal. — — —

I desire, on behalf of the Smithsonian Institution, as well as of the Committee, to thank you for the interest you have taken in this matter.

— — — — — —

With great respect etc. etc.

(signed) *S. P. LANGLEY*,
SECRETARY.

C. L. MADSEN, ESQ.

HELSINGOR, near COPENHAGEN,
DENMARK.

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ERRATA.

		Error.	*Correction.*
Page 4 ..	last line	+ $26_{,6458}$ . . .	+ $22_{,6458}$
— 15 ..	margin	Tab. II og III . .	Tab. II—III
— 21 ..	last line	Part IX, § 66 . .	Part IX.
— 76 ..	N. A. 37° 30′/47° 30′ . .	+ $1_{,87}$	+ $2_{,87}$
	N. A. 27° 30′/77° 30′ . .	+ $2_{,23}$	+ $2_{,33}$
	N. A. 27° 30′/47° 30′ . .	+ $2_{,29}$	+ $2_{,22}$
	Charleston	+ $0_{,68}$	— $0_{,68}$
— 118 ..	37th line	July 1885	July . .
Tab. IV ..	Section VI . . 25°/0° . .	— $6_{,560}$	+ $6_{,560}$

Besides some few literal misprints, not requiring special mention.

THERMO-GEOGRAPHICAL STUDIES.

I.

EQUATIONS FOR THE NORMAL MEAN YEARLY TEMPERATURE OF THE PARALLELS.

Introductory remarks and definitions.

1. *The solar climate,* defined by the normal mean yearly temperature of the parallels, generally forms the foundation of researches on the distribution of temperature over the surface of the earth; this definition may be said to rest upon the idea of the rotating globe being exposed to the rays of the sun, the sun placed at mean distance in zenith over the equator, and of a transformation of the surface of the earth so as to represent an average of the actual physical constitution. The constant and uniform temperature of the parallels, resulting from this position and superficial constitution of the earth, is equal to the normal mean yearly temperature of the parallels, derived from actual observations and reduced to the sea-level. Now, the broken uniformity in the mean annual temperature of places along a parallel represents for each place the effect of the real state of things, and the difference between the normal and the actually observed mean yearly temperature of a place may therefore be taken as caused by the thermal action of the surface itself. This difference, or the effect of the local thermal conditions, is in these researches defined as *the annual thermo-geographical component,* and to ensure the highest possible exactness in the representation of this important element of physical geography a corresponding degree of correctness in the determination of the normal mean yearly temperature of the parallels is in the first place required. — There are, besides, other reasons, to be discussed in the following, which, too, have induced the Author to spend a great deal of work in order to secure as much as possible the satisfactory construction of the finally adopted parallel equations.

Taking into consideration the nature of the problem and the analogies with geodætical operations, the method of least squares has in these researches been exten-

sively applied, particularly for the construction of the numerical equations for the normal mean yearly temperature of parallels and places, the geographical positions of which are given.

The parallel-equations. Tab. I.

In Tab. I will be found the numericals given by different Authors, as well as the equations, which either have been at disposal for the construction of the fundamental equation V, or otherwise are of interest in the matter. The following are the numericals, which have served as basis for the different equations referred to in the table.

II. v. Freeden. 1863, Northern Hemisphere

$\varphi =$	0°	10°	20°	30°	40°	50°	60°	65°	70°	80°	90°
$T\varphi =$	21,2	21,3	20,2	16,8	10,9	4,3	−0,8	−4,2	−7,1	−11,2	−13,2 °R

III. The Author. 1890

N.H. $\varphi =$	21°4′	32°34′	38°54′	46°3′	51°37′	59°46′	65°10′	70°24′
$T\varphi =$	25	20	15	10	5	0	−5	−10 °C
S.H. $\varphi =$	15°45′	26′30′	37°54′	46′54′	53°47′			
$T\varphi =$	25	20	15	10	5 °C			

IV. The Author. 1892

N.H. $\varphi =$	10°	20°	30°	40°	50°	60°	65°	70°
$T\varphi =$	27,110	25,276	20,313	13,782	5,813	−1,008	−4,768	−9,198 °C
S.H. $\varphi =$	10°	20°	30°	40°	50°	60°	65°	70°
$T\varphi =$	25,361	23,008	18,862	12,454	6,476	0,263	−2,415	−4,846 °C

V. The Author. 1892

N.H. $\varphi =$	0°	10°	20°	30°	40°	50°	60°	65°	70°	80°	90°
$T\varphi =$	28,036	27,382	24,996	20,128	13,760	6,203	−1,203	−4,940	−9,090	−16,018	−21,434 °C
S.H. $\varphi =$	0°	10°	20°	30°	40°	50°	60°	65°	70°	80°	90°
$T\varphi =$	26,521	25,556	22,922	18,592	12,570	6,493	0,344	−2,405	−4,909	−9,045	−11,622 °C

The normal yearly temperature of any parallel or place of the latitude $= \varphi$ is now determined by the equations, which are derived from the fundamental quantities by the operations and the method of least squares, as shown in Tab. I, and composed as follows for the different thermometrical scales,

degrees Centigrade,

Northern Hemisphere . . . . $T\varphi = 31{,}7544\ cos\ \varphi + 18{,}6395\ cos\ \varphi^2 - 21{,}7620$ . . . . (1)
Southern Hemisphere . . . . $T\varphi = 10{,}0371\ cos\ \varphi + 28{,}3073\ cos\ \varphi^2 - 11{,}6545$ . . . . (2)

degrees Fahrenheit,

Northern Hemisphere . . . . $T\varphi = 57{,}1579\ cos\ \varphi + 33{,}5511\ cos\ \varphi^2 - 7{,}1716$
Southern Hemisphere . . . . $T\varphi = 18{,}0668\ cos\ \varphi + 50{,}9531\ cos\ \varphi^2 + 11{,}0219$

degrees Réaumur,

Northern Hemisphere . . . . $T\varphi = 25{,}4035\ cos\ \varphi + 14{,}9116\ cos\ \varphi^2 - 17{,}4096$
Southern Hemisphere . . . . $T\varphi = 8{,}0297\ cos\ \varphi + 26{,}6458\ cos\ \varphi^2 - 9{,}3236$

From the equations (1) and (2) the normal temperature of the parallels has been calculated as follows (Tab. I),

	Hemisphere Northern	Southern
the Pole	—21,762 °C	—11,655 °C
Parallel 80°	—15,686	— 9,058
70°	— 8,721	— 4,910
65°	— 5,013	— 2,357
60°	— 1,225	+ 0,441
50°	+ 6,351	6,493
40°	13,501	12,646
30°	19,718	18,268
20°	24,537	22,773
10°	27,587*)	25,684*)
the Equator	28,632*)	26,690*)

If now the above calculated series of temperature be compared to the fundamental quantities for the equation V, it will be seen, that both series are almost identical; the proof of exactness, usually applied to the method of least squares, gives therefore for the equation V the very satisfactory result, that the sum of the square of errors is found to be

	N.H.	S.H.
for equation V (1892)	1,2324	0,1910
but for equation II (1863)	8,052	—

As far as the Author is aware, the equation II is one of the earliest composed equations, and hence the above figures confirm the considerable progress now made in the exactness, with which the equation V reproduces the actual observations. They further show, that any desired improvement of the equation V requires the introduction of fresh statistical materials, the present records being fully utilized**).

It may further be observed, that the fundamental numericals for the equation III are the means of a double interpolation of *Andrées* system of Isothermals for the year, which it was considered right to add to the statements of *Dove, J. Hann, Spitaler, Mohn* and *Freeden*. Those of J. Hann and Spitaler are doubtless the most reliable, and the addition of the almost identical series of Mohn gives them accordingly double weight. — In the case of the equations III and IV the extreme latitudes are left out in consequence of the uncertainties, which from natural causes prevail in the statements of temperature in these regions; the continuation of the curve of temperature, as determined by the stringent method employed and based upon the fundamental points from 10° to 70° lat., is no doubt to be preferred.

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*) For the modification of these figures, see § 4, the equatorial zone.

**) Several attempts have been made with equations composed of 4 terms, but they were not attended with any perceivable advantage, or at any rate not sufficient to repay the great inconvenience in operating with more complicated formulæ or equations of higher order.

From the above introductory observations it may be concluded, that the different views and statements of the thermal condition of the surface of the earth, and particularly in the extreme tropical and polar zones, are, as shown in detail in Tab. I, brought into due co-operation by the formation of the equations 1 and 2; for this reason and owing to their exact working, the same may be considered as at present the most acceptable equations for the normal mean yearly temperature of the parallels of both hemispheres, whilst the form of the equations renders them particularly well adapted for several researches beyond the immediate use; in the following will be found examples of such applications.

Formulæ of reduction of temperature to mean latitude.

2. At present the graphical representation of the distribution of the mean yearly temperature by means of Isothermals is in general use; from the principles for the construction of such systems it follows, that the middle-line of the curves represents parallels of the corresponding latitude and temperature, and consequently the mean latitude of the middle-line of any given isothermal line can be determined by the formulæ of reduction, derived from the equations 1 and 2, and given in Tab. I as follows,

for the northern hemisphere

$$\cos \varphi = 0{,}_{2316} \sqrt{T\varphi + 35{,}_{2861}} - 0{,}_{8518} \quad \ldots \quad \ldots \quad (3),$$

for the southern hemisphere

$$\cos \varphi = 0{,}_{18795} \sqrt{T\varphi + 12{,}_{5442}} - 0{,}_{1773} \quad \ldots \quad \ldots \quad (4).$$

From these formulæ the mean latitude of Isothermals for the year, generally represented in meteorological works, is determined for both hemispheres as follows (Tab. I):

Isothermals	N.H.	S.H.
— 10° C	71° 46′	82° 58′
— 5°	64° 59′	70° 11′
0°	58° 24′	60° 46′
+ 5°	51° 48′	52° 25′
10°	45° 1′	44° 21′
15°	37° 45′	36° 0′
20°	29° 30′	26° 30′
+ 25°	18° 49′	13° 0′

The formula (3) for the northern hemisphere has besides been of importance in several researches concerning the mean yearly temperature of parallels and places of different latitudes, which will be fully dealt with in the following chapters.

Northern and southern parallels of equal latitude and temperature.

3. The difference in the thermal state of the two hemispheres is a well known phenomenon, and conspicuous in the series of temperature in the columns 17 and 18 of Tab. I, as well as in the table of the mean latitude of Isothermals given above. From the tables it will be seen, that the northern hemisphere from the equator to a parallel between 45° and 50° lat. has a higher temperature than the corresponding southern hemisphere, but, that the last mentioned in respect to temperature is the most favoured in the regions between the pole and the same parallel. The line of thermal equilibrium, or the parallels

of equal latitude and temperature, are now easily determined by the equations (1) and (2), and found to be the parallel of $48^0\,49'$ lat. N. and S., both of the normal yearly temperature $+ 7{,}_{2245}\,^0$C.

The parallel $48^0\,49'$ N. is in geographical respects of a peculiar interest; it will namely be found, that the same traverses in eastern as well as in western longitudes the most extended continental zones of the northern hemisphere, and in Europe and Asia also that region, in which the thermal influences from West and South — the Atlantic and the Gulf stream, Sahara and the Mediterranean — meet each other; the parallel $48^0\,49'$ S. is on the contrary in its total length almost entirely „oceanic"; the remarkable features of both parallels, thus demonstrated, classify these results among the immediate observations, which in an eminent degree have contributed to the plan, adopted and fully exposed in part II of these researches.

4. In the tables of Dove, J. Hann, Spitaler and Mohn, produced in Tab. I, the maximum of temperature is placed in the parallel 10^0 N., *the thermal equator;* but from the equations it follows, that the max. lies in the geographical equator, and the series show, besides, a difference in temperature of about 2^0 C for this latitude. — It is evident, that a difference cannot exist at all, and that an equalization on this point, and the displacement of the thermal max., would require a re-construction of the equations. It seems, however, that it would be more in harmony with the natural conditions to introduce, instead of a thermal equator, an *equatorial zone,* including the 10^0 lat. N. and S. and consequently of a uniform temperature throughout. This plan recommends itself for several reasons; the observations are for inst. rare, for large areas entirely wanting; the actual differences of temperature within these parallels and over the total equatorial zone are in reality as well as analytically extremely small; the determination of temperature in sharply defined lines would therefore on the one side be partly unfounded, and on the other side of very little practical value. It must also be remarked, that the equal distribution of land and water within the 10^0 lat. N. and S. offers an argument in favour of the proposed equatorial zone, in which region the calms, the trade-winds and the equatorial currents work in the same sense. — Admitting now the correctness of the equations to about the 10^0 lat., the uniform yearly temperature of the equatorial zone may be put down to the mean of the six parallels or to $+ 27{,}_{233}\,^0$C, which shows a decline of $0{,}_{354}\,^0$C from the calculated temperature of the thermal equator at 10^0 N. $= + 27{,}_{587}\,^0$C.

Special zones and parallels.

Observations of this kind have caused the Author to omit in several places the temperature of parallels under 10^0 lat., but of course the question of the thermal equatorial zone must be left open for further considerations in connection with researches on the movement of temperature in the tropical zone.

The normal yearly temperature of the special parallels $23^0\,27'$ and $66^0\,33'$ may be of interest, and they are therefore given here in order to complete the series in the columns 17 and 18 of Tab. I.

	Northern Hemisphere	Southern Hemisphere
$66^0\,33'$	$- 6{,}_{1736}\,^0$C	$- 3{,}_{1774}\,^0$C
$23^0\,27'$	$+ 23{,}_{0574}$	$+ 21{,}_{3781}$

Mean temperature of zones, the hemispheres and the earths surface.

5. The mean yearly temperature of the earths surface, or of any part of the same, may be determined in accordance with the following table, constructed by means of the equations (1 and 2) and Tab. I; the element of surface taken = 1000 sq. kilometres*). The mean yearly temperature of the equatorial zone has in this table been modified as stated in § 4, and the area of each zone calculated from Bessels numericals of the dimensions of the globe.

Zone	Area of the zone in 1000 sq. kilom.	Mean temp. × number of elements of the area. Northern Hemisphere	Southern Hemisphere
0 to 10° lat.	44372,7	+ 1.208410 °C	+ 1.208410 °C
10 - 20° „	43007,5	1.131150	1.051610
20 - 30° „	40323,3	900330	834440
30 - 40° „	36409,0	610110	566590
40 - 50° „	31392,7	314430	301260
50 - 60° „	25435,5	+ 65720	+ 86870
60 - 70° „	18722,4	— 93850	— 44120
70 - 80° „	11457,2	— 140860	— 82040
80 - 90° „	3856,5	— 72710	— 40740
	total = 254976,8	= + 3.922730 °C	= + 3.882280 °C

From this table the following data are derived,

mean yearly temperature of the northern hemisphere . . . . . + 15,385 °C
do. of the southern hemisphere . . . . . + 15,226 °C

and

mean temperature of the surface of the earth . . . . . + 15,3 °C

and further

	Northern Hemisph.	Southern Hemisph.
mean yearly temperature of the zone 0 to 50° lat.	+ 21,301 °C	+ 20,267 °C
do. of the zone 50 to 90° lat.	— 4,014 °C	— 1,312 °C

and of

the tropical zone, 0 to 23° 27′ lat.	+ 26,37 °C	+ 25,34 °C
the temperate zone, 23° 27′ to 66° 33′ lat. . . .	+ 11,33 °C	+ 10,98 °C
the polar zone, 66° 33′ to 90° lat.	— 12,29 °C	— 7,02 °C

It will thus be seen, that the surplus of temperature of the northern hemisphere to about the parallel of 50°, at an average amounting to about 1° C, is almost entirely

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*) If the surface of the earth, or any part of the same, be composed of the areas A_1 A_2 A_3 . . . ., each area expressed in number of elements of say 1000 sq. km. each, and the corresponding mean yearly temperature of each area be t_1 t_2 t_3 . . . ., then the mean yearly temperature of that surface is $= \frac{A_1 t_1 + A_2 t_2 + A_3 t_3 + \ldots .}{A_1 + A_2 + A_3 + \ldots .}$.

compensated by the still higher temperature in the southern latitudes from 50° towards the South-Pole, and that therefore the mean temperature of both hemispheres is almost equal or about + 15,3 °C. These results are almost the same as those obtained by Dr. Wilh. Schoch by different methods and in his Inaugural Dissertation of August 9, 1856 given as follows:

mean yearly temperature	of the northern hemisphere	+ 12,05 °R
do.	of the southern hemisphere	+ 11,93 °R

and

mean temperature of the surface of the earth	+ 11,99 °R

General geographical observations.

6. The above results of the equations (1) and (2) harmonize exceedingly well with the leading features of the physical geography. The equal mean temperature of the total surface of both hemispheres for inst., depends not only on the circumstance that both hemispheres receive the same quantity of heat from the sun, the source of all heat in our system, but also on the fact, that no sensible part thereof is conveyed from one hemisphere to the other, and this for the reason, that the systems of constant currents acting on the surface of both hemispheres are circular, and do not in their course leave that hemisphere in which they originate and expire. So are the best known of the constant currents, the Gulf stream and the Kuro Siwo, entirely northern currents, and particularly the first named has fully the appearance of a formidable conveyance of heat from the tropical zone to higher latitudes in the north-atlantic middle-zones, whilst the Kuro Siwo performs the same duty, but on a less intensive scale, in the pacific ocean. — The mighty currents originate, the one in the Gulf of Mexico and the other in the Chinese Sea; the former has but one outlet, the narrow strait of Florida, the latter several connections with outer waters in different directions. The conditions determinating the intensity of heat are consequently from the very outset in favor of the atlantic Gulfstream, which further on, having in several branches traversed the north-atlantic ocean, meets the north-atlantic plateau and is thrown in northerly direction along the coast of Norway and then passed through comparatively narrow channels into the polar regions. — On the other side the Kuro Siwo meets with no obstacles on its way outside the chain of islands, bordering the eastern coast of Asia, and in crossing the broad pacific ocean; hence, after the long voyage the current reaches the north-american west coast in a reduced state, following the same in southerly direction. The moderate character of the thermal action of the Kuro Siwo is about typical for the system of circular currents on the southern hemisphere, and the comparative action of all the currents is explicitly illustrated in the system of annual isothermals, of which the southern and the pacific parts leave an impression like ripples on the surface of smooth inland waters, as compared with the mighty and steep waves passing over the Gulfstream region of the North-Atlantic zone.

The identical tendency, but unequal thermal power or intensity of the existing systems of oceanic currents, resulting in more uniform temperature and climate*) on the southern and more abnormal thermal conditions on the northern hemisphere, is also demonstrated by the annual amplitude of temperature, which for the northern hemisphere is about 50° C. or more than 10° C. over that of the southern hemisphere.

From the above observations it follows, that any alteration in the present configuration of the earths surface and particularly in the distribution of land and water, or of any other partial factor affecting the thermal intensity of any of the currents, would be limited in its thermal effect to that particular hemisphere in which the change takes place; it seems therefore to be in accordance with the geographical conditions if in thermal researches both hemispheres are continually treated separately, the more so, as then the phenomena caused in the distribution of the annual temperature by an eventual desorganisation of the acting dynamic or physical powers may be subjected to analytical investigations with more stringens and less complication.

The fundamental character which the parallel-equations acquire in these studies will no doubt be found confirmed by the preceding considerations and remarks, and not the least by the marked congruency of results of great magnitude obtained by different Authors and methods.

Remarks on planetary and solar temperature.

7. The constant mean temperature of the earths surface is apparently a planetary factor, which from a cosmical point of view, and being derived from actual observations, possibly may be useful as a moment in the much debated question of the temperature and physical constitution of the sun. At present a perfect mystery must be said to prevail in these matters, and a contribution to the elucidation af the same, given with all reservation, may therefore not be out of place, for that reason, too, that the temperature obtained places itself in about the middle of the list of mutually quite incongruent statements, which the Author purposely has collected from different works.

The mean temperature of the earths surface, measured at the bottom of the atmosphere to + 15,3 °C, determines the constant and uniform mean temperature of a sphere, of exactly the same physical constitution as the globe externally and placed in the mean distance of the earth from the suns centre, to about + 61 °C, which again gives the constant temperature of a similiar sphere in the immediate proximity of the suns surface about equal to $2^3/_4$ millions degrees Centigrade, representing the minimum of heat continually emanating from the sun.

The extreme discrepancy in the current hypotheses on the temperature of the sun, alluded to above, is clearly demonstrated in the following paragraphs.

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*) It is for inst. expressly noticed, that the climate of Argentine, of the districts of the Cape and of New Zealand, all countries situated in about the same southern latitude, are also equally favored in respect to climate, the winter described as being mild and the summer of moderate heat.

	degrees Centigrades
Dr. Aug. Ritter estimates according to exhaustive researches the temp. in the centre of the sun, when supposed to consist of dry atmospheric air, to	450 millions
but when consisting of hydrogen, to	31,3 „
According to Dr. W. Meyer the surface temp. of the sun is by different Authors estimated from	10 „
to	300000
Dr. Will. Siemens according to his experiments gives the temperature of the sun	3000
Other Authors even as low as	1500
Dr. Joh. Müllers handbook of cosmical physic, according to Dr. Zöllner,	
temperature of the suns atmosphere	27000
temperature of the interior of the sun	70000
Recent experiments by Dr. Wilson & Gray, Birmingham, give the temperature of the sun	6200

Another series of investigations (by Langley, Violle, Pouillet and others) result in the following statements:

1 Kilogr. of the mass of the sun to contain 43 millions cal. and to transmit of heat $1^1/_3$ °C annually or $1^1/_2$ quart-trillions cal., an amount of heat capable of melting an iron block of 700 cub. miles (Maury) or a layer of ice over the earths surface of a thickness of 31 metres (Pouillet), 45 metres (A. Paulsen) or 54 metres (Mohn).

1 square meter of the suns surface in each second to perform a work equal to 75000 H. P. or 13—14 millions cal.

and, supposing the sun to consist of one homogeneous mass of the best coals, this would maintain the present temperature (of the earths surface?) for about 4600 years.

II.

EQUATIONS AND FORMULÆ FOR THE DETERMINATION OF THE MEAN YEARLY TEMPERATURE OF PLACES OF GIVEN GEOGRAPHICAL LATITUDE AND LONGITUDE.

Introductory remarks.

8. In the introduction with which Professor Frank Waldo of the meteorological service, U. S. A., accompanies his before mentioned translation of Dr. Wilh. Schochs treatise on the problem before us, he says „In whatever manner the problem is taken up it is merely the question of an interpolatious formula; — that is, given a number of temperature observations at different points on the earths surface, to combine them in such a way that the observations themselves will be represented, and will permit the determination of the probable temperature at intermediate points.“ — Prof. W. is no doubt right in his assertions and his view on actual observations of temperature as the fundament of any attempt to solve the problem is in exact accordance with the principles, which the Author has followed througout in the present studies. But it seems that the difficulties which evidently and in an exceptional measure surround this problem, since it is still left undecided, call for some explanations, and for the reason, that they have been conclusive for the methods and plan followed in this attempt, the Author thinks it right briefly to state in this place his views on these points.

The partial solution of the problem.

In the first place it deserves to be pointed out, that any attempt to represent the mean yearly temperature of any place on the earths surface by means of one and the same equation, and as a function of the geographical latitude and longitude, necessarily must lead to most complicated formulæ, because scarcely two points exist in which the thermal and geo-physical elements and conditions are exactly alike. A limitation of the geographical territory, followed by a reduction in number of the acting factors, seems therefore advisable and to be the only plan which probably will permit of formulæ, adapted for general use; it seems also to be a matter of consequence, that the partial solution*) of the problem promises to be the more effective for the reason,

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*) The partial or step by step solution is a well known and practical mode of proceeding in problems of much complicated nature.

that, by using this plan, certain geo-physical facts of predominant importance and influence (the Gulf-stream for inst.) could be taken into account and more especially represented in the ensuing formulæ. Such were the reflections, which from the beginning have led to the adopted plan, and which by and by has been modified during the work.

It may as well at this place be remarked, that the thermal formulæ for well defined sections of the earths surface conveniently allow corrections to be made, totally as well as partly, an advantage of this system which scarcely can be overrated. — It appears further on more logically and natural to refer the determination of the local temperature to special formulæ representing the proper section, because, as shown, the general equation of the temperature of the parallels satisfies all general inquiries relative to the principal distribution of heat on the surface of our planet.

As for the statistical foundation it was a matter of course, that one of the existing systems of isothermals for the year, representing all the preparatory work required for the analytical proceedings, was to serve for the purpose, and after some discussion of this important point with Professor, Dr. Neumayer, the system constructed and published under the Authority of Professor Dr. Jul. Hann in „Atlas der Meteorologie“, 1887, was selected as basis for further operations. According to Prof. Hann's elaborate and comprehensive introduction, the above system of Isothermals, designed and executed to a convenient scale and with the utmost care, is based upon all recent and authentic publications and works, and hence the plan in every way affords the most reliable record of all available observations, in an authoritative manner reduced to sea-level and prepared for the usual graphical representation. — It remains then to transform this graphical record into the numerical one required for analytical purposes, an operation which will be fully treated in the next paragraphs.

The oscillations in the records of temperature, and the fact, that by the nature of the phenomena, the exact verification of the analytical formulæ by means of direct observations is absolutely excluded, are too well known to call for more than a notice in passing, but that peculiar circumstance should be named, that whilst in practical meteorology all records entirely and exclusively depend on the daily readings, the reverse operation takes place in the analytical proceedings, in which the annual temperature is the fundamental quantity from which the movement in temperature or the mean temperature of the months or any other unit of time is to be derived by means of special formulæ.

Accordingly, the important task to be dealt with in this part of the studies comprises the establishment of the statistical fundament together with the construction of the required equations and formulæ representing the same; consequently, the next step to be taken in order to complete the task includes proofs of the application and the precise working of this part of the analytical thermo-geographical system.

9. In order to obtain the most reliable statistical fundament the following proceedings were adopted. By careful measurements and interpolations on the above named map of isothermal lines, constructed by Prof. Dr. Jul. Hann, the annual temperature of 469

The statistical fundament.

positions on the northern hemisphere and at the sea-level were determined, and afterwards revised and corrected. The positions are given by 11 parallels, ranging from 25° to 75° N., and 44 meridians, namely the Greenwich meridian and each 10° long. westwards and eastwards, besides the meridians 5°, 15° and 25° W. and E., and 115° and 125° W., which were selected for eventual special purposes. — 25 positions in the parallel 75° are missing on the plan.

For the purpose of revision all the interpolated temperatures in each parallel and for the usual 36 main meridians were referred to the middle-line represented in each parallel by the given normal temperature of the same (equation [1], Tab. I); the correction to be applied in each parallel was then determined by the sum of the ordinates in the said meridians, the difference of the positive and negative ordinates being divided proportionally according to the number of ordinates in each series and to the character of the difference. The following scheme gives an example of all the details of the operations in the parallel of 60° N.; the temperature of the positions were interpolated by measuring the interval of the two enclosing isothermals and the difference of one of them, generally the nearest to the point concerned, and the proportion presented then the difference in temperature and finally the interpolated temperature.

	W.	180°	170°	160°	150°	140°	130°	120°	110°	100°	90°	80°	70°	60° W.
Interpol. temp.	°C	0	−0,400	−1,200	+4,000	+4,572	+1,000	−1,460	−3,600	−6,000	−7,684	−8,194	−6,868	−3,359
Normal temp. of the parallel 60°		−1,225	being subtracted from the interpol. temp. leaves the ordinate or											
the annual thermo-geogr. component		+1,225	+0,825	+0,025	+5,225	+5,797	+2,225	−0,235	−2,375	−4,775	−6,459	−6,969	−5,643	−2,134

	W.	50°	40°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60°	70° E.
Interpol. temp.	°C	+0,680	+3,265	+5,607	+6,730	+7,000	+7,844	+4,833	+5,042	+3,790	+2,356	+1,400	−0,500	−2,080
the ordinate or thermo-geogr. comp.		+1,905	+4,490	+6,832	+7,955	+8,225	+9,069	+6,058	+6,267	+5,015	+3,681	+2,625	+0,725	−0,855

	E.	80°	90°	100°	110°	120°	130°	140°	150°	160°	170° E.
Interpol. temp.	°C	−2,785	−3,000	−3,700	−6,000	−7,538	−8,267	−7,267	−5,600	−4,788	−2,000
the ordinate or thermo-geogr. comp.		−1,560	−1,775	−2,475	−4,775	−6,313	−7,042	−6,042	−4,375	−3,563	−0,775

Correction — sum of the 18 positive ordinates . . . . . + 78,169° C
„ 18 negative ordinates . . . . . − 68,140°
Difference . . . . . = 10,029°
or for each of the 36 meridians . . . . . = ∓ 0,2785° C

This correction of about 1/4° C represents that displacement of the 8 Isothermals, enclosing the parallel of 60° N., which is required in order that the middleline of the same or of the 36 normal ordinates coincide with the Parallel-Equation giving for 60° N. the normal mean yearly temperature = — 1,2249 °C. — The operations are in reality carried out with 4 dec.; one positive ordinate (160° W.) becomes by the correction negative. In the same manner are the corrections determined, which are applied to the other parallels in the above named system of Isothermals for the Year.

The following table contains a summary of these operations.

Interpolation

	lat.	70°	65°	60°	55°	50°	45°	40°	35°	30°	25°	75°
number of + ordinates		11	13	18	19	17	17	21	19	21	27	11
„ of — ordinates		25	23	18	17	19	19	15	17	15	9	—
sum of + ordinates	°C	77,986	70,440	78,167	60,923	46,656	35,085	45,934	43,490	51,185	67,530	63,685
„ of — ordinates	—	119,687	97,702	68,142	70,084	69,287	51,646	24,367	24,784	25,632	17,737	—
correction to be applied	—	±1,158	±0,757	∓0,279	±0,255	±0,629	±0,460	∓0,599	∓0,520	∓0,710	∓1,383	±1,000 (approx.)

After correction

number	of + ordinates	13	13	17	20	18	22	17	18	19	17	12
„	of — ordinates	23	23	19	16	18	14	19	18	17	19	24
mean value	of + ordinates °C	7,111	6,176	4,318	3,290	3,201	2,037	2,022	1,874	1,937	2,203	6,301
„	of — ordinates —	4,019	3,490	3,863	4,112	3,201	3,202	1,809	1,874	2,165	1,971	3,151

In the above corrections are also included the small but unavoidable errors, which for one reason or another and in spite of all care might have occurred; the corrections are also applied to the intermediate meridians referred to above.

From the table it will be seen, that the displacement of the curves in northerly or southerly direction, or the correction required to obtain the perfect congruency of the isothermal system and the normal temperature of the parallels, for the most part are inconsiderable; together with the change of signs this confirms the thorough harmony of the original system of annual isothermals and the equation (1), the mean temperature of any parallel, derived either way, being nearly the same. The thus verified mean yearly temperature of the selected 469 geographical positions is represented in the Table II and III, and may now be taken as a correct transformation of the graphical system into the numerical foundation for the following analytical proceedings. Tab. II og III.

The following additional remarks may contribute to our general informations in respect to some of the characteristic features of the systems of annual isothermals, perceivable in the tables. — The distribution of the positive and negative ordinates*) and the mean value of the same mark for inst. the intensity of the thermal terrestrial factors, and from the tables it will be seen, that in the parallel 50° N. the number and value of the ordinates balance each other, i. e. that in this parallel another thermal equilibrium takes place in distinct conformity with the before determined thermal state of the hemispheres. From the parallel 50° and northwards the positive ordinates in

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*) The number of the + and — ordinates has been somewhat altered by the corrections, and accordingly a modification in the mean value took place; in 25° lat. this re-distribution of the ordinates is more visible owing to the frequent turns in the course of the isothermals in the southern latitudes.

more and more reduced number increase in intensity to about 70° lat., where a max. is reached, thus showing a more concentrated effect of the geographical factors tending to raise the temperature, whilst the larger number and less intensity of the negative ordinates, representing the flatness of the curves in the downward branches, agree with the fan-shaped, rapidly spreading influence from polar regions, favoured by the plains of the northern continents of Asia and America. — It is a peculiar circumstance, that on the part of the globe from 50° lat. and northwards the positive and negative ordinates, very unequal in number, form but two continuous groups, whilst south of 50° lat. the ordinates become more spread and combined in several lengths towards the equator. This distinction in the course of the isothermals points direct to the different nature of the thermo-geographical factors, an observation of great importance for the plan worked out and followed in the present analytical attempts.

For further observations in respect to the movement of the mean annual temperature over the northern hemisphere the Author refers to the details given in Tab. II and III, which both are provided with explanatory remarks.

The annual thermo-geographical component.

10. The important element „the annual thermo-geographical component", defined as the difference of the mean yearly temperature of a place and the normal mean yearly temperature due to the latitude of the place, is determined and will be found in Tab. II and III for each of the 469 geographical positions on the northern hemisphere.

The Author is of the opinion that this thermal factor is exceedingly well adapted to complete or replace the usual graphical representation of the yearly isothermals, and that plans of the globe showing the annual thermo-geographical components of the mean yearly (level) temperature at regularly distributed geographical positions would offer a valuable and easily mastered contribution to our knowledge of the most important element of meteorology, of the manner in which the oceans and continents partake in and regulate the temperature of the globes surface, and generally to our knowledge of physical geography.

The elimination of the cosmical part of the local temperature leaves to the terrestrial part a character of continuity in the direction of the meridians, of rare occurence in tables of temperature, which renders this factor the character of an expedient of control, that has already been of use in these investigations. This plan, too, would afford a well arranged material for interpolations, the more valuable as the interpolated quantities only form a fraction and frequently but a small fraction of the total temperature of the place and of the registered numericals.

The thermo-geographical component of the mean yearly temperature will often be dealt with in other parts of these researches, and part VIII: On the systematic, numerical representation of the distribution of temperature over the surface of the earth, shows a design of the geographical representation of the component as proposed above.

11. After numerous but unsuccesful attempts and extensive preliminary researches the following program was found to be that, which in all probability would lead to equations of the desired simplicity in form and exactness in function.

The general equation of the mean yearly temp. of places situated on the northern hemisphere.

If the equation (1) for the northern hemisphere be given the form

$$M = 31{,}_{7544}\ cos\ \varphi_1 + 18{,}_{6395}\ cos\ \varphi_1{}^2 - 21{,}_{7620} \quad . . \quad . . \quad (5),$$

all variations in the annual temperature observed on the total area of the northern hemisphere are included in the term $cos\ \varphi_1$, whilst the proved coefficients and the negative term remain constant.

The variable term.

The advantage and simplification in all operations accrueing from this generalized and uniform equation of temperature are evident, and, in the Authors opinion, the expectations in this respect, as well as in regard to exactness, have all been realized in the numerous applications of the completed formulæ, which hereafter will be specified.

It should be noticed that the function $arc\ cos\ \varphi_1$ represents the „improved“ latitude of the place concerned, i. e. the displacement in latitude*) corresponding to a temperature, lower or higher than the normal one, due to the lat. φ.

The numerical value of the term $cos\ \varphi_1$ is calculated from the interpolated and corrected mean yearly temperature by the formula of reduction

$$cos\ \varphi_1 = 0{,}_{2316}\ \sqrt{M + 35{,}_{2361}} - 0{,}_{8518} \quad . . \quad . . \quad (3),$$

and is given in Tab. II for 273 geographical positions situated in 25 meridians extending from 90° W. to 90° E and in the 11 parallels from 75° to 25° lat., as mentioned above.

12. The construction of Meridian-Equations or a special formula for each meridian for the determination of the numerical value of the variable term $cos\ \varphi_1$ has been the object of many and combinated, but quite unsuccesful attempts. The experiments, with one and the same equation to cover the total length of Greenwich and other meridians, having all failed by giving quite unacceptable results, the parallel of 50° N. was for the previously stated reasons, which will be completed hereafter, finally selected as the limiting parallel for the formation of a northern and a southern group of formulæ. In the following it will be shown that by this plan all analytical difficulties have been removed and perfectly satisfactory results obtained.

Special formulæ for the variable term.

*) This mode of comparing the local and the normal temp. of a place is no doubt of considerable interest from a geographical point of view; the amount of displacement is easily determined either direct by the formula (3), or by interpolation in Tab. I, col. 17.

The Meridian-Equations.

The 38 special formulæ for the meridians from 90° W. to 90° E. were finally constructed by means of the method of least squares, the fundamental value being taken from Tab. II and combined as follows

for each meridian of the northern group		for each meridian of the southern group
75° — 70° — 65° — 60° — 55° and 50° lat.	and	50° — 45° — 40° — 35° — 30° and 25° lat.

The formulæ resulting from this process are produced in the annexed table on the following page, to which is added the usual proof of exactness, given in the column headed $\Sigma\,(F—G)^2$.

On glancing over the 38 formulæ the remarkable difference, numerically as well as in respect to the signs, which is found in the two formulæ completing one and the same meridian, will at once be observed; no doubt, this characteristic feature in the construction offers moments of great interest for geographical considerations, particularly because one single exception from the rule shows, that identical formulæ are not entirely excluded. The exceptional case is found in the meridian 20° E., and the close resemblance of the two formulæ makes it most probable, that in this meridian certain analogies in the terrestrial conditions may be found*), just as the dissimilarity in all the other meridians points to differently acting thermal powers in the northern and southern groups**).

13. The object of the special formulæ to serve as the immediate numerical fundament for the establishment of the final equations has made it an absolute condition to aim at the highest possible degree of exactness in all the operations and results; the annexed table proofs, that the efforts have in this respect been successful, and the following

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*) Perhaps the following remarks may be found to approach an explanation. On looking over the map, the middle part along the meridian 20° E. will be found to consist of cultivated ground, in continuation of which follow extensive waters of nearly the character of inland seas, while the said meridian terminates in North in the gulfstream and in South in the Sahara, both productive of surface heat. The ground along the meridian is consequently uniformly arranged, although not homogeneons in the sense of the imaginary surface upon which the parallel-equation rests, and the co-operating formulæ may therefore also present a uniformity, which in fact is the case in the said meridian, but not observed in any other. — No doubt, these exceptional conditions deserve a close examination, on account of the analogies to which they may lead, and in the interest of the matter the Author gives here the formula constructed for the total length of this meridian, together with the special formulæ for the northern and southern part of the same,

$$\cos\varphi_1 = 0{,}29538\cos\varphi + 0{,}37040\cos\varphi^2 + 0{,}36097 \quad .. \quad 90^0 — 0^0 \text{ lat.}$$
$$= 0{,}26820\cos\varphi + 0{,}41542\cos\varphi^2 + 0{,}36434 \quad .. \quad 90^0 — 50^0 \text{ lat.}$$
$$= 0{,}26751\cos\varphi + 0{,}40714\cos\varphi^2 + 0{,}35822 \quad .. \quad 50^0 — 0^0 \text{ lat.}$$

**) The sensibility of the geographical and analytical functions has in this direction been proved by the fact, that in the Greenwich meridian the formulæ for any of the two groups cannot be applied to parallels reaching 10 degrees beyond the boundary parallel without causing serious disturbances in the now obtained precision.

SPECIAL FORMULÆ

for the determination of the numerical value of the function $cos\,\varphi_1$ for places situated in the northern (90°—50° lat.) and southern (50°—0° lat.) part of each of the 19 normal meridians in the Atlantic middle-zones of the northern hemisphere.

Meridian	NORTHERN GROUP		SOUTHERN GROUP	
	90°—50° lat. N.	$\Sigma(F\text{-}G)^2 =$	50°—0° lat. N.	$\Sigma(F\text{-}G)^2 =$
90° W.	$+ 0{,}13940\ cos\,\varphi + 0{,}97645\ cos\,\varphi^2 + 0{,}05732$	$0{,}000645$	$+ 2{,}13656\ cos\,\varphi - 0{,}55901\ cos\,\varphi^2 - 0{,}57884$	$0{,}000531$
80° „	$- 0{,}15651\ cos\,\varphi + 1{,}18701\ cos\,\varphi^2 + 0{,}14529$	$0{,}001462$	$+ 1{,}66824\ cos\,\varphi - 0{,}17702\ cos\,\varphi^2 - 0{,}45102$	$0{,}000162$
70° „	$+ 0{,}00507\ cos\,\varphi + 0{,}93576\ cos\,\varphi^2 + 0{,}14878$	$0{,}001146$	$+ 3{,}06239\ cos\,\varphi - 1{,}03727\ cos\,\varphi^2 - 0{,}99907$	$0{,}001146$
60° „	$+ 1{,}30739\ cos\,\varphi - 0{,}64240\ cos\,\varphi^2 - 0{,}02366$	$0{,}003081$	$+ 4{,}00592\ cos\,\varphi - 1{,}69565\ cos\,\varphi^2 - 1{,}31301$	$0{,}000887$
50° „	$+ 1{,}88661\ cos\,\varphi - 1{,}13776\ cos\,\varphi^2 - 0{,}12202$	$0{,}000493$	$+ 4{,}64419\ cos\,\varphi - 2{,}30745\ cos\,\varphi^2 - 1{,}41020$	$0{,}000129$
40° „	$+ 2{,}14080\ cos\,\varphi - 1{,}29122\ cos\,\varphi^2 - 0{,}15473$	$0{,}001407$	$+ 3{,}16653\ cos\,\varphi - 1{,}56522\ cos\,\varphi^2 - 0{,}69524$	$0{,}000287$
30° „	$+ 1{,}95493\ cos\,\varphi - 1{,}19415\ cos\,\varphi^2 - 0{,}04207$	$0{,}001008$	$+ 1{,}59680\ cos\,\varphi - 0{,}67702\ cos\,\varphi^2 - 0{,}01544$	$0{,}000057$
20° „	$+ 1{,}40735\ cos\,\varphi - 0{,}68951\ cos\,\varphi^2 + 0{,}11720$	$0{,}000132$	$- 0{,}34513\ cos\,\varphi + 0{,}54037\ cos\,\varphi^2 + 0{,}74403$	$0{,}000088$
10° „	$+ 1{,}06489\ cos\,\varphi - 0{,}30407\ cos\,\varphi^2 + 0{,}19044$	$0{,}000050$	$- 4{,}39007\ cos\,\varphi + 3{,}25155\ cos\,\varphi^2 + 2{,}23411$	$0{,}000098$
Greenwich	$+ 2{,}09481\ cos\,\varphi - 1{,}53390\ cos\,\varphi^2 + 0{,}01393$	$0{,}000764$	$- 4{,}74400\ cos\,\varphi + 3{,}70342\ cos\,\varphi^2 + 2{,}26149$	$0{,}000697$
10° E.	$+ 1{,}33948\ cos\,\varphi - 0{,}96431\ cos\,\varphi^2 + 0{,}19770$	$0{,}003695$	$- 2{,}15767\ cos\,\varphi + 2{,}04596\ cos\,\varphi^2 + 1{,}26271$	$0{,}000420$
20° „	$+ 0{,}26820\ cos\,\varphi + 0{,}41542\ cos\,\varphi^2 + 0{,}36434$	$0{,}000276$	$+ 0{,}26751\ cos\,\varphi + 0{,}40714\ cos\,\varphi^2 + 0{,}35822$	$0{,}000712$
30° „	$+ 0{,}62227\ cos\,\varphi - 0{,}10992\ cos\,\varphi^2 + 0{,}31611$	$0{,}001331$	$+ 1{,}81119\ cos\,\varphi - 0{,}57801\ cos\,\varphi^2 - 0{,}25727$	$0{,}000103$
40° „	$+ 0{,}49245\ cos\,\varphi + 0{,}03783\ cos\,\varphi^2 + 0{,}32284$	$0{,}001176$	$+ 2{,}95971\ cos\,\varphi - 1{,}23012\ cos\,\varphi^2 - 0{,}73388$	$0{,}000637$
50° „	$+ 0{,}38533\ cos\,\varphi + 0{,}27266\ cos\,\varphi^2 + 0{,}28196$	$0{,}000037$	$+ 1{,}56169\ cos\,\psi - 0{,}23292\ cos\,\varphi^2 - 0{,}27300$	$0{,}000593$
60° „	$+ 0{,}92623\ cos\,\varphi - 0{,}06704\ cos\,\varphi^2 + 0{,}06343$	$0{,}000427$	$+ 3{,}11744\ cos\,\varphi - 1{,}23292\ cos\,\varphi^2 - 0{,}87459$	$0{,}000212$
70° „	$+ 1{,}26308\ cos\,\varphi - 0{,}30193\ cos\,\varphi^2 - 0{,}07150$	$0{,}000653$	$+ 4{,}24031\ cos\,\varphi - 1{,}81988\ cos\,\varphi^2 - 1{,}37463$	$0{,}000425$
80° „	$+ 1{,}44136\ cos\,\varphi - 0{,}41256\ cos\,\varphi^2 - 0{,}15765$	$0{,}000269$	$+ 4{,}19248\ cos\,\varphi - 1{,}85404\ cos\,\varphi^2 - 1{,}32515$	$0{,}000303$
90° „	$+ 1{,}05981\ cos\,\varphi + 0{,}11931\ cos\,\varphi^2 - 0{,}11347$	$0{,}000325$	$+ 1{,}62907\ cos\,\varphi - 0{,}30745\ cos\,\varphi^2 - 0{,}30202$	$0{,}000110$

data taken from the table will no doubt confirm this statement. It will namely be found, that the sum of the expression

$$\Sigma (F\text{-}G)^2$$

amounts to,

for the northern groups	$0_{,018377}$
„ „ southern —	$0_{,007597}$
or at an average, for the northern groups	$0_{,000967}$
„ „ southern —	$0_{,000400}$

and that the maxima are found

in the meridian 10° E., northern group	$0_{,003695}$
and in the meridian 60° W., northern group	$0_{,003081}$

and the minima

in the meridian 50° E., northern group	$= 0_{,000037}$
and in the meridian 10° W., northern group	$0_{,000050}$

That several of the formulæ only have been accepted after repeated computation has doubtless materially contributed to the fact, that the deviations from the original transformations on the whole are inconsiderable.

The terms of the formulæ and particularly the constants call for special remarks, for inst. the regular oscillations of the positive constant in the northern parts of the meridians from 30° W. to 60° E., but at present it seems advisable to postpone considerations on these points. The max. of deviations found in the northern part of the meridians 10° E. and 60° W. are clearly due to the very complicated thermal and geographical conditions of the northern part of Norway and Davy's Strait, which would require special studies in order to be represented more accurately and in detail by local equations. On the other hand, the minima of deviation are in good harmony with the purely continental and oceanic, i. e. thoroughly uniform character of the surface traversed by the northern parts of the respective meridians 50° E. and 10° W.

General formulæ for the variable term in the sections I-VIII of the Atlantic middle-zones.

14. The division of the Atlantic middle-zones by the parallel 50° lat. N. has been followed by a further division by the meridians 0°, 50° W. and 50° E.; consequently, that part of the earths surface, on which these analytical operations take place, has been divided into 8 Sections, namely

Section	I	90°—50° N.,	0°—50° E.	Section V	90°—50° N., 0°—50° W.
—	II	50°— 0° N.,	0°—50° E.	— VI	50°— 0° N., 0°—50° W.
—	III	90°—50° N.,	50°—90° E.	— VII	90°—50° N., 50°—90° W.
—	IV	50°— 0° N.,	50°—90° E.	— VIII	50°— 0° N., 50°—90° W.

The arguments for the division by the parallel 50° need not be repeated; they have been much strengthened by the experiences, successively reported in the preceding paragraphs and later on in this work; the division by the meridians are made on account of the necessity for expressing the formulæ for the term $cos\ \varphi_1$ in that trigonometrical function of degrees longitude (λ), which gives coefficients of the least numerical

value; accordingly the sine-function was selected for the sections on both sides of Greenwich meridian (I—II—V—VI) and the cosine-function for the sections ending in the 90° meridians (III—IV—VII—VIII); a division at 50° long. W. and E. was the consequence of these reflections, the practical range of which was tried by preliminary calculations.

In accordance with these dispositions and all the preparatory work, the general formulæ for the determination of the numerical value of the term $cos\ \varphi_1$ assumed the form

$$cos\ \varphi_1 = A\ cos\ \varphi + B\ cos\ \varphi^2 + const \quad .. \quad .. \quad (6),$$

in which

for the sections I—II—V and VI

$$A = a \quad sin\ \lambda + b \quad sin\ \lambda^2 + const$$
$$B = a_1 \quad sin\ \lambda + b_1 \quad sin\ \lambda^2 + const_1$$
$$C = a_{11} \quad sin\ \lambda + b_{11} \quad sin\ \lambda^2 + const_{11}$$

and for the sections III—IV—VII and VIII

$$A = a \quad cos\ \lambda + b \quad cos\ \lambda^2 + const$$
$$B = a_1 \quad cos\ \lambda + b_1 \quad cos\ \lambda^2 + const_1$$
$$C = a_{11} \quad cos\ \lambda + b_{11} \quad cos\ \lambda^2 + const_{11}$$

The 9 coefficients and constants for each section were finally determined by the method of least squares applied to the fundamental coefficients and constants (A, B and C) given in the 38 special formulæ for the 19 normal meridians. The following plan indicates the distribution of these quantities.

The fundamental numericals A, B and C are taken from the special formulæ for the meridians:

Section	I, northern group	0°	10°	20°	30°	40°	50° E.
—	II, southern group	0°	10°	20°	30°	40°	50° E.
—	III, northern group	50°	60°	70°	80°	90°	E.
—	IV, southern group	50°	60°	70°	80°	90°	E.
—	V, northern group	0°	10°	20°	30°	40°	50° W.
—	VI, southern group	0°	10°	20°	30°	40°	50° W.
—	VII, northern group	50°	60°	70°	80°	90°	W.
—	VIII, southern group	50°	60°	70°	80°	90°	W.

The results of the whole work, comprising

the formation of the formulæ for the determination of the numerical value of the variable function $cos\ \varphi_1$ for any geographical position in the 8 sections defined above, and consequently

the formation of the complete system of equations and formulæ required for the analytical determination of the mean yearly temperature at sea-level and in degrees Centigrade of positions and places, situated in the 8 sections,

are represented in the annexed table (page 23), and also in full details and with explanatory notes given in the Codification of the thermo-geographical formulæ, coefficients and definitions, together with the log. of all the coefficients and constants, part IX, § 66.

15. The mean yearly temperature of the geographical positions, specified in Tab. II, has now been determined by means of the completed equation and formulæ, and the result of each application registered in Tab. IV. — The usual proof for correctness of the operations has been successively employed for each of the constants A, B and C; but the details of this control are not repeated here for the reason, that the classification of the absolute deviations, obtained by comparison of Tab. II and IV, gives more instructive and accurate informations in respect to the working of the whole system.

Tab. IV.

Comparison of the statistically ascertained and the calculated mean yearly temperature of positions in the Atlantic middle-zones.

16. The general proof of the precision of the completed equations, referred to in § 15, is in full extent presented in the table on page 24, showing the difference (Tab. IV—Tab. II) of the calculated and the fundamental, statistically ascertained temperature of the 207 geographical positions*), specified in Tab. II; in addition to this table the following classification of the differences still better demonstrates the degree of exactness obtained in the general working of this system of equations of temperature.

From the table it will namely be seen, that in respect to magnitude of difference the total number of observations may be classified thus

$\pm$ 0,000 to 1,000 °C	174	observations	or 84,1 %
$\pm$ 1,000 to 2,000 °C	28	—	or 13,5 %
beyond $\pm$ 2,000 °C	5	—	or 2,4 %

With reference to this classification it should be remembered, that the 5 observations in the high latitudes of the meridians 60° W. (3), 10° E. (1) and 30° E. (1), showing this extraordinary difference, are rather doubtful for the reasons previously set forth in discussing the special formulæ; besides, they are all negative and also in respect to signs disturbing the uniformity otherwise observeable in the distribution of the differences**).

The following details complete the classification of the above differences,

$\pm$ 0,000 to 0,100 °C	19	observations	or 9,2 %
$\pm$ 0,100 to 0,250	31	—	or 15,0 %
$\pm$ 0,250 to 0,500	53	—	or 25,6 %
$\pm$ 0,500 to 0,750	45	—	or 21,7 %
$\pm$ 0,750 to 1,000	26	—	or 12,6 %
$\pm$ 1,000 to 2,000	28	—	or 13,5 %
beyond $\pm$ 2,000	5	—	or 2,4 %

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*) For places in the limiting meridians and parallels the means of the positions in Tab. IV are taken.

**) The sum of the positive and negative differences amounts to + 57,208 and — 70,589; if the abnormal 5 negat. observations be excluded the differences are about equal and = + 57,208 and — 55,131, giving a mean difference of about $\pm$ 0,27 °C.

EQUATIONS AND FORMULÆ

for the determination of the mean yearly temperature in degrees Centigrade of places situated at the sea-level in the Atlantic middle-zones of the northern hemisphere.

In the general equation of temperature . . . . . $M = T\varphi,\ \lambda = 31{,}7544\ cos\ \varphi_1 + 18{,}6395\ cos\ \varphi_1{}^2 - 21{,}7620$

the numerical value of the coefficients and constants of the variable term . . . . . $cos\ \varphi_1 = A\ cos\ \varphi + B\ cos\ \varphi^2 + C$

is determined by the formulæ I—VIII corresponding to the sections I—VIII referred to in this table.

	90° W.	50° W.	Greenwich meridian	50° E.	90° E.	
90° lat. N.						90° lat.
	VII.	V.	I.	III.		
	$A = -2{,}70161\ cos\lambda + 8{,}91021\ cos\lambda^2 + 0{,}08850$	$A = -2{,}02655\ sin\lambda + 3{,}26446\ sin\lambda^2 + 1{,}81712$	$A = -5{,}98948\ sin\lambda + 5{,}07830\ sin\lambda^2 + 2{,}11504$	$A = +2{,}64787\ cos\lambda - 5{,}86332\ cos\lambda^2 + 1{,}08710$		
	$B = +1{,}88795\ cos\lambda - 8{,}71053\ cos\lambda^2 + 1{,}04923$	$B = +2{,}78413\ sin\lambda - 3{,}93672\ sin\lambda^2 - 1{,}23360$	$B = +5{,}89857\ sin\lambda - 4{,}82135\ sin\lambda^2 - 1{,}57473$	$B = -3{,}08218\ cos\lambda + 5{,}37581\ cos\lambda^2 + 0{,}07322$		
	$C = +0{,}72780\ cos\lambda - 1{,}62672\ cos\lambda^2 + 0{,}06337$	$C = +0{,}36598\ sin\lambda - 0{,}91659\ sin\lambda^2 + 0{,}06596$	$C = +1{,}32125\ sin\lambda - 1{,}29482\ sin\lambda^2 + 0{,}01704$	$C = -0{,}49323\ cos\lambda + 1{,}72737\ cos\lambda^2 - 0{,}11579$		
50° lat.						50° lat.
	VIII.	VI.	II.	IV.		
	$A = +0{,}51359\ cos\lambda + 6{,}25344\ cos\lambda^2 + 1{,}91968$	$A = +12{,}71012\ sin\lambda + 0{,}74145\ sin\lambda^2 - 5{,}32047$	$A = +21{,}77053\ sin\lambda - 16{,}32470\ sin\lambda^2 - 5{,}04553$	$A = +16{,}57634\ cos\lambda - 26{,}70945\ cos\lambda^2 + 1{,}77857$		
	$B = +0{,}66993\ cos\lambda - 5{,}83562\ cos\lambda^2 - 0{,}43177$	$B = -10{,}00184\ sin\lambda + 1{,}92985\ sin\lambda^2 + 4{,}08319$	$B = -14{,}57032\ sin\lambda + 11{,}37870\ sin\lambda^2 + 3{,}92441$	$B = -9{,}90779\ cos\lambda + 16{,}00868\ cos\lambda^2 - 0{,}39749$		
	$C = -0{,}86043\ cos\lambda - 1{,}09450\ cos\lambda^2 - 0{,}48766$	$C = -3{,}84676\ sin\lambda - 1{,}70757\ sin\lambda^2 + 2{,}47173$	$C = -8{,}11544\ sin\lambda + 5{,}79514\ sin\lambda^2 + 2{,}36650$	$C = -6{,}68688\ cos\gamma + 10{,}79453\ cos\lambda^2 - 0{,}36127$		
Equator						Equator
	90° W.	50° W.	0°	50° E.	90° E.	

COMPARISON

of Tab. IV and Tab. II, showing the difference of the calculated and the interpolated mean yearly temperature of the 207 geographical positions specified in Tab. II.

	W.									Greenwich meridian	E.								
	90°	80°	70°	60°	50°	40°	30°	20°	10°		10°	20°	30°	40°	50°	60°	70°	80°	90°
lat. 75° N.	+0,251	+0,561	+0.327	−1,773	+0,257	+1,193	+0,571	−0,378	+0,224	+0,455	+0,407	+1,278	+0,562	+0,054	+0,271	−0,001	−0,380	−0,246	−
70°	−0,642	+0,620	−0,917	−3,644	−0,682	+0,401	−1,417	−0,598	+0,707	−0,260	−3,375	−	−2,024	−1,946	+0,088	+0,965	+0,577	+0,238	+0,106
65°	−0,471	−0,559	−0,568	−4,312	+0,560	−1,378	−1,173	−0,183	+1,129	−1,235	−0,425	+1,358	−0,068	−0,710	+0,189	−0,143	−0,507	−0,411	+0,179
60°	+0,501	+0 708	+0,808	−2,103	+0,616	+0,287	−0,051	+0,380	+0,960	+0,855	+1,036	+0,184	+0,014	+0,174	+0,061	+0,116	+0,318	−0,127	−0,608
55°	+0,501	+0,714	+0,993	−1,011	+0,454	+0,552	+0,189	+0,696	+1,000	+0,439	+0,374	−0,097	−0,141	+0,331	+0,116	−0,522	−0,846	+0,718	+0,548
50°	+0,083	−0,817	−0,562	−1,741	−0,157	−1,173	−0,531	+0,433	+0,116	−0,031	+0,172	−0,356	+0,013	−0,519	−0,090	−0,282	−0,038	+0,108	−0,306
45°	−0,900	+0,233	+0,460	+1,311	+0,566	+0,126	−0,574	−0,324	+0,446	−0,656	−0,982	+0,807	+0,662	−0,517	+0,380	+0,626	+1,006	−0,426	+0,429
40°	+0,909	−0,168	+0,805	+0,494	+0,703	−0,429	−0,293	+0,176	+0,739	−1,083	−0,610	−0,950	+0,287	+0,281	+0,886	+0,799	−0,223	−0,485	−0,152
35°	−0,210	+0,426	−1,192	−0,884	+0,101	−0,989	−0,660	+0,184	+1,020	+0,857	−0,256	+0,099	+0,373	−1,762	−0,817	+0,315	−0,373	+0,710	+0,094
30°	−0,530	−0,285	−1,047	−0,986	−0,014	−0,797	−0,831	+0,294	+0,449	−0,005	−0,516	+1,088	+1,024	−0,925	−0,872	+1,396	−1,156	−0,575	+0,495
25°	+0,135	+0,466	+1,336	+0,185	+0,457	−0,266	−0,249	+0,390	+0,282	+0,740	−1,728	−0,254	+0,548	+0,013	+0,389	+1,115	−0,642	−0,350	−0,111

The general classification, given page 22, shows then, that out of a total number of observations the probability in the analytical determination of the mean yearly temperature is as follows

for about 50 % a difference of less than $\pm$ ½ °C,
„ „ 34 % „ „ between ½ and 1 °C, and
„ „ 14 % „ „ „ 1 and 2 °C,

whilst a number of about 2 % is at present doubtful.

In respect to the geographical distribution of the difference between the calculated and interpolated temperature the table gives the following interesting informations:

	$\pm$ 0,50 and less	$\pm$ 0,50 to 1,00	$\pm$ 1,00 to 2,00 °C
in longitudinal direction			
Greenwich Meridian	5	4	2
West of do.	43	39	14
East of do.	55	28	12
in latitudinal direction			
the parallel of 50° lat. . .	13	4	2
North of 50° lat.	43	33	12
South of 50° lat.	47	34	14

This comparison seems to indicate a tendency of the equations to work with a somewhat greater precision in the Eastern than in the Western quadrant, whilst no such difference in the function is apparent in the comparison of the latitudes North and South of the parallel 50°.

In addition to the above class of inquiries on the probable exactness of the equations, and the general working of the same in reference to that system of annual isothermals which they represent, a most important moment, characteristic for this partial system of equations, deserves special attention. From the table of equations and formulæ, annexed § 14, and from Tab. IV it will namely be seen, that in the completion of the general formulæ of the term $cos\ \varphi_1$ the data of the positions in the meridians 50° W., 0° and 50° E. as well as in the parallel 50° N. are taken into account for each of the adjacent sections; accordingly the corresponding equations co-operate in the coincident points, where the sections and equations, 4 and 4, meet. This arrangement is made purposely for the sake of continuity and control, and the following scheme will now demonstra‘e the satisfactory working of the same*).

*) There are several other points in the said meridians and parallels, in which the equations, 2 and 2, meet and co-operate; the tables afford the means of examining the effect of the plan in regard to these points.

Order of the co-operating equations . .

	50° W.		0°		50° E.	
50° N.	VII	V	V	I	I	III
	VIII	VI	VI	II	II	IV

corresponding calcul. temperature . .

	50° W.		0°		50° E.	
50° N.	+ 4°,762	+ 5°,476	+ 11°,016	+ 11°,110	+ 6°,335	+ 6°,524
	+ 4°,943	+ 5°,669	+ 11°,878	+ 12°,229	+ 6°,090	+ 5°,962

	50° W.	0°	50° E.
means of the calcul. temperature	+ 5°,213	+ 11°,558	+ 6°,228
the corrected interpolated temperature . .	+ 5°,370	+ 11°,589	+ 6°,318
difference	— 0°,157	— 0°,031	+ 0°,090

The approximation in these three points, in which the working of the whole system is represented, will no doubt be accepted as decisive in respect to the proof of the uniform exactness of the total system, but in stating this, the Author furthermore feels convinced, that the plan of co-operating equations will be of vital importance in questions of re-construction of the present system.

But even granted, that the above analytical system with quite acceptable precision represents the graphical system of isothermals for the year selected as foundation for the same, and leaving at present the question, whether the deviations, according to the theory of the method of least squares, may be taken as approximations to the true mean temperature or not, still the relation of this analytical system to original actual observations of temperature cannot yet be considered as finally proved. For this purpose the Author has completed the Tab. IX, which will be fully dealt with in part IV of these researches.

On concluding now this part of investigations bearing upon the precision of the equations and formulæ produced, and already now remarking, that the results of Tab. IX in respect to „differences“ also move within narrow limits, the Author thinks it right to repeat, that the nature of the problem, and the complete want of means to classify in regard to exactness the meteorological statistics from different periods, reserves to time alone the power to decide in the question of the highest attainable approximation, provided that, as years pass away, the stability in the present system of thermal forces shall not be disturbed.

17. In the results of the application of the complete formulæ for the determination of the mean yearly temperature of geographical positions in the sections I—VIII of the Atlantic middle-zone (Tab. IV), part of the arctic regions as well as the equatorial zone have been excluded for that reason, that the formulæ in the application for extreme parts of the earths surface do not give quite satisfactory results; a correction is therefore required, and such has already been employed for the zone reaching 10° North and South of Equator (§ 4). In regard to the arctic regions and particularly that part, which lies between the meridians 90° W. and E., the correction is naturally of a more complicated character, and the researches are therefore only recently (1896) advanced so far as to admit of a method, which probably may render the analytical proceedings concerning arctic temperature more correct.

Preliminary remarks on the formation of arctic tables of temperature, 1896.

Especially *Dr. Fridtjof Nansens* Polar-Expedition (1893—96) and his observations, unknown to the Author at the moment this is written, are likely to afford the means of controlling the result of the calculatory methods, and with a view to use this interesting situation, the Author under the date of October 17, 1896, has deposited at the Smithsonian Institution, Washington, a memorandum stating the calculated temperature of the year and of the months at *Nansens point,* 86° 14′ lat. and 90° E. long., the northermost point ever reached by any polar expedition.

But at the same time the occasion is taken to prove the practicability of the formulæ and methods for completing certain series of observations, extending over part of a year only, which have been carried out by the Danish expeditions to *Angmagsalik* (8 months, 1884—85), and to the *Isle of Denmark* (Scoresby Sound, 11 months, 1891—92), both places situated at the eastern coast of Greenland*).

Full particulars of the observations and the analytical proceedings, as well as of the formation of the corrected arctic tables, are given in Part VII: „Additional studies on the temperature of places in the arctic zone (1896)“, and in the Codification (Part IX); with the remark, that the additional arctic researches form an introductory part of the investigations on the distribution of temperature in high latitudes, mentioned in the Introduction, we now in the following table proceed to give a survey of the calculated and corrected mean yearly temperature of several arctic positions.

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*) *Angmagsalik,* Capt. *G. Holm,* R. N., October 1884—May 1885.
Isle of Denmark (Scoresby Sound), Capt. *M. C. Ryder,* R. N., September 1891—July 1892.
The observations are published 1889 and 1895 by the Met. Inst. of Denmark under the direction of *A. Paulsen* and *M. Willaume-Jantzen.*

Table showing the calculated mean yearly temperature of arctic positions situated in different latitudes between 90° W. and 90° E.

	West									Greenwich meridian	East								
	90°	80°	70°	60°	50°	40°	30°	20°	10°		10°	20°	30°	40°	50°	60°	70°	80°	90°
At the North Pole										−21,76									
At the lat. 87° 30′										−20,34									
85°	−19,00	−18,93	−19,73	−19,95	−18,68	−20,31	−16,82	−18,39	−18,15	−19,36	−16,93	−16,71	−16,64	−17,32	−17,85	−19,24	−19,82	−19,67	−18,94
80°	−17,90	−17,30	−18,08	−16,67	−14,04	−15,78	−12,24	−11,04	−10,48	−11,42	− 6,89	− 8,06	− 7,78	− 9,30	−11,52	−15,54	−17,53	−18,16	−17,59
75°	−16,12	−15,32	−15,56	−13,25	− 9,81	−10,54	− 6,50	− 4,99	− 4,35	− 4,47	− 0,29	− 2,39	− 2,17	− 3,90	− 6,81	−11,64	−14,18	−15,37	−15,30
70°	−13,70	−13,05	−12,21	− 9,50	− 6,03	− 4,64	− 1,65	− 0,31	+ 0,21	+ 1,46	+ 2,83	+ 0,26	+ 0,15	− 1,16	− 3,77	− 7,57	− 9,83	−11,36	−12,11
65°	−10,83	−10,60	− 8,97	− 6,34	− 2,56	+ 0,42	+ 2,29	+ 3,44	+ 3,84	+ 5,80	+ 4,33	+ 1,98	+ 1,32	+ 0,40	− 1,43	− 3,78	− 5,50	− 6,99	− 8,15

Further considerations on this table and on the isothermal lines which may correctly be postponed to Part VII, the Discussion of Observations; but already now it may be remarked, that the table shows clearly that in the eastern quadrant the maximum of temperature according to the table moves from the Pole in north-easterly direction from about Greenwich meridian in the lat. 65° towards the lat. 85° in the lat. 30° E. approaching the Pole; a minimum of temperature is in the lat. 85° found in the meridian of 70° and 40° W.

The narrow dimensions of the areas, which are encircled by the parallels from the Pole towards and within the lat. 85°, makes it the most probable, that a uniform temperature prevails at all approaches to the extreme arctic territory, also for that reason, that the meridians in these high latitudes run so close to each other, that little space is left for any difference in temperature of the different meridians.

The above preliminary remarks, and the arctic table itself, agree fairly well with the general representations of the isothermal lines for the year and the polar regions, and particularly with that system, constructed by Dr. Alexander Buchan and published in Part V of the Challenger Reports, 1889.

III.

EQUATIONS AND FORMULÆ FOR THE DETERMINATION OF THE YEARLY MOVEMENT IN THE TEMPERATURE OF PLACES IN THE NORTHERN TEMPERATE AND POLAR ZONE.

Introductory remarks and definitions.

18. The yearly movement in the temperature of a place is generally represented by the mean temperature of the calendar months, the arithmetical means of which in praxis, but not quite correct, give the mean yearly temperature*). Analytically the process is reversed, and the mean monthly temperature, marking stations in the normal distribution of temperature over the year, determined as a function of the mean yearly temperature, taken as the given observed or calculated standard temperature of the place. From these remarks it follows, that the method employed in the researches on the analytical determination of the mean yearly temperature is not applicable in respect to the monthly temperature, and that a direct solution of this problem in the sense of an analytical approximation to the natural development of the phenomenon seems to be much less complicated, and at the same time promising of infinitely more valuable results of the work, than what could possibly be expected of a mere mechanical repetition of the „annual“ process.

As far as the Author is aware no attempt in this direction has hitherto been made, and in introducing this part of the present researches it may therefore not be found inopportune briefly to sketch such of the preliminary statistical experiments and other arguments, which at an early period in a suggestive manner encouraged to proceed with the investigations relative to this, in many respects deeply interesting part of the entire thermo-geographical problem.

Now, on looking over tables of the monthly temperature of a large number of places, and observing how widely they differ from each other, it will be admitted, that

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*) Correctly the mean yearly temperature should be equal to the arithmetical means of all the mean daily temperature, but the inconveniences caused by this proceeding would far surpass the small errors committed by the method followed in praxis, and which in fact entirely disappear, when compared to the considerable oscillations, observed in the series of temperature from year to year.

a reduction of all the individual series of temperature to one and the same standard is indispensable for obtaining a basis for an immediate comparison of the movement in temperature from month to month of all places, whatever their geographical position in the northern temperate or polar zone may be*), it being at the same time strictly understood, that such reduction not in the least shall alter or interfere with the characteristics of the original series of observations.

The following leading points may be taken as a guide for this reduction; they include the generally known characteristical marks of the series of monthly temperature of places in the said zones:

the highest and lowest temperature is generally found in the months of July and January respectively, and it will also be found that August as a rule has a higher temperature than June, which takes the third place in the series;

the mean temperature of July and January is nearly equal to the mean yearly temperature of the place, and

the amplitude of the yearly movement of temperature increases in the direction from South to North, and from the oceans towards the centres of the great continents.

In addition to these starting points the Author notes, that the North-American continent from its geographical position appeared more likely to produce uniform observations of temperature, i. e. less influenced by superficial forces, than Europe and Asia, and that therefore in the very first attempts the observations were taken from the western continent.

Preliminary analytical and statistical researches and formulæ.

19. If now the series

$$t_1 \quad t_2 \quad t_3 \ldots\ldots t_{12}$$

denote the mean temperature of the months January, February, March . . . . December of any place in the northern temperate or polar zone, and M the corresponding mean yearly temperature, then we have

$$\frac{t_1 + t_2 + t_3 + \ldots\ldots t_{12}}{12} = M$$

and further

$$\frac{t_1 - M}{t_7 - M} + \frac{t_2 - M}{t_7 - M} + \frac{t_3 - M}{t_7 - M} + \ldots\ldots \frac{t_{12} - M}{t_7 - M} = Q_1 + Q_2 + Q_3 + \ldots\ldots Q_{12} = 0$$

from which

$$t_1 = Q_1 (t_7 - M) + M$$

$$t_2 = Q_2 (t_7 - M) + M$$

or generally

$$t_m = Q_m (t_7 - M) + M \ldots\ldots\ldots (7).$$

---

*) In part VI these researches are extended to the tropical zone and the southern hemisphere.

On pausing at this point it will be observed, that the quotient Q_m in the formula (7) evidently represents the factor, which regulates the movement in the original series, and further, the variable term $(t_7 - M)$ being at present left undecided*), that the success depends upon, in the first place, whether a satisfactory conformity and regularity in the movement of the quotients Q_1 Q_2 . . . . Q_{12}, when derived from different and even extreme series, can be statistically proved, and, secondly, upon the definition and numerical determination of the true or normal value of these quotients.

Accordingly a number of series of observations from very differently situated places in North-America were selected for the required preliminary statistical investigations**); the results are stated hereafter together with those, obtained from the series of New York and Fort Franklin, of which the details are given here to examplify the operations.

New York $\varphi = 40^0\,43'$ N. $\lambda = 74^0\,1'$ W. $H = 50$ metres.

	Jan.	Febr.	March	April	May	June	July	Aug.	Septb.	Octob.	Novbr.	Decbr.	M
mean temp. obs.	$-4{,}250$	$-0{,}250$	$+4{,}875$	$+11{,}625$	$+16{,}875$	$+19{,}875$	$+22{,}875$	$+22{,}125$	$+18{,}000$	$+11{,}625$	$+5{,}625$	$+1{,}250$	$+10{,}854$ °C.
$(t_m - M)$	$-15{,}104$	$-11{,}104$	$-5{,}979$	$+0{,}771$	$+6{,}021$	$+9{,}021$	$+12{,}021$	$+11{,}271$	$+7{,}146$	$+0{,}771$	$-5{,}229$	$-9{,}604$	
$\frac{t_m - M}{t_7 - M} = Q_m$	$-1{,}257$	$-0{,}924$	$-0{,}497$	$+0{,}064$	$+0{,}501$	$+0{,}750$	$+1{,}000$	$+0{,}938$	$+0{,}595$	$+0{,}064$	$-0{,}435$	$-0{,}799$	

Fort Franklin $\varphi = 65^0\,12'$ N. $\lambda = 123^0\,13'$ W. $H = 72$ metres.

mean temp. obs.	$-30{,}125$	$-27{,}125$	$-20{,}750$	$-10{,}875$	$+1{,}750$	$+8{,}875$	$+11{,}125$	$+10{,}250$	$+5{,}000$	$-5{,}250$	$-17{,}875$	$-23{,}875$	$-8{,}2396$ °C.
$(t_m - M)$	$-21{,}885$	$-18{,}885$	$-12{,}510$	$-2{,}635$	$+9{,}990$	$+17{,}115$	$+19{,}365$	$+18{,}490$	$+13{,}240$	$+2{,}990$	$-9{,}635$	$-15{,}635$	
$\frac{t_m - M}{t_7 - M} = Q_m$	$-1{,}130$	$-0{,}975$	$-0{,}646$	$-0{,}136$	$+0{,}516$	$+0{,}884$	$+1{,}000$	$+0{,}955$	$+0{,}684$	$+0{,}154$	$-0{,}498$	$-0{,}807$	

The following is a list of the geographical position of 11 places, which have afforded the statistics for the above mentioned preliminary experiments.

	φ	λ	H		φ	λ	H
Boothia Felix	$69^0\,59'$	$92^0\,1'$ W	—	Albany	$42^0\,39'$	$73^0\,44'$ W	39 metres
Nain	$57^0\,10'$	$61^0\,50'$	4 metres	Council Bluffs	$41^0\,25'$	$95^0\,43'$	239 —
Sitka	$57^0\,8'$	$135^0\,18'$	5 —	Marietta . .	$39^0\,25'$	$81^0\,30'$	—
Fort Vancouver	$48^0\,37'$	$122^0\,37'$	—	Fort Ross . .	$38^0\,34'$	$122^0\,59'$	—
Quebec	$46^0\,48'$	$71^0\,17'$	95 metres	St. Augustine	$29^0\,50'$	$81^0\,27'$	—
Concorde . .	$43^0\,12'$	$71^0\,29'$	—				

*) In the following the Author succeeded in eliminating the variable difference $(t_7 - M)$, and to substitude for the same another annual quantity, derived from actual observations.

**) All statistics for the preliminary researches were taken from Doves tables partly re-published in Dr. Joh. Müllers Handbook of cosmical physic, 4th edition, Braunschweig, 1883. The observations are originally given in Réaumur, but here reduced to degrees Centigrade.

The preliminary statistical inquiries gave then the following mean value of the quotient Q_m for each of the 12 months

		New York	Fort Franklin	Means of the 11 places	Means of the 13 places
January .	Q_1 . .	$-1,_{257}$	$-1,_{130}$	$-1,_{001}$	$-1,_{030}$
February . .	Q_2 . .	$-0,_{924}$	$-0,_{975}$	$-0,_{919}$	$-0,_{923}$
March	Q_3 . .	$-0,_{497}$	$-0,_{646}$	$-0,_{632}$	$-0,_{623}$
April	Q_4 . .	$+0,_{064}$	$-0,_{136}$	$-0,_{142}$	$-0,_{126}$
May	Q_5 . .	$+0,_{501}$	$+0,_{516}$	$+0,_{373}$	$+0,_{394}$
June	Q_6 . .	$+0,_{750}$	$+0,_{884}$	$+0,_{781}$	$+0,_{786}$
July	Q_7 .	$+1,_{000}$	$+1,_{000}$	$+1,_{000}$	$+1,_{000}$
August	Q_8 . .	$+0,_{938}$	$+0,_{955}$	$+0,_{962}$	$+0,_{959}$
September . .	Q_9 . .	$+0,_{595}$	$+0,_{684}$	$+0,_{662}$	$+0,_{659}$
October . .	Q_{10} . .	$+0,_{064}$	$+0,_{154}$	$+0,_{130}$	$+0,_{131}$
November . .	Q_{11} . .	$-0,_{435}$	$-0,_{498}$	$-0,_{378}$	$-0,_{391}$
December . .	Q_{12} . .	$-0,_{799}$	$-0,_{807}$	$-0,_{842}$	$-0,_{836}$

To complete this scheme the sum of the positive quotients, $\Sigma\ (+\ Q_m)$, is more accurately determined for each of the 13 series and arranged as follows according to the latitude of the place

Boothia Felix	$3,_{7870}$	Albany	$3,_{8215}$
Fort Franklin	$4,_{1926}$	Council Bluffs	$4,_{0634}$
Nain	$4,_{1950}$	New York	$3,_{9116}$
Sitka	$4,_{0147}$	Marietta	$3,_{7847}$
Fort Vancouver	$3,_{7518}$	Fort Ross	$4,_{0644}$
Quebec	$3,_{5862}$	St. Augustine	$4,_{2132}$
Concorde	$3,_{9337}$		

Mean value of $\Sigma\ (+\ Q_m)$ of 13 series $= 3,_{9477}$.

The stringent working of the plan for the reduction of all observations to one standard, visible in the above statistical analysis, is the more surprising if it be remembered, that the numerical values of the quotient Q_m in several places are derived from observations of short periods, and from places spread over a whole continent, and presenting a difference of about 40 degrees of latitude and 74 degrees of longitude between the extreme points.

Even now, long after the true meaning and the theoretical value of the quotients Q_m have been ascertained and verified by recent and authentic statistics from all quarters of the northern hemisphere, the Author feels satisfied, that the preliminary results, though imperfect in the origin, nevertheless give unmistakeable evidences of the existence of mutual factors, which govern numerically the general movement of temperature in perfect accord with the recurrency of the phenomenon itself, and which lie concealed among local and other factors, acting together in the numberless observations.

If now the above quotients Q_m for the months be represented graphically, the resemblance between the curve and the Ecliptic would at once be recognized; at the same time the dip of Q_1 and particularly the general displacement of the ordinates show, that the thermal curve, analytically, is of a more complicated nature, than either a sinuscurve or the Ecliptic itself; but the predominant dynamo-cosmical character of the thermal curve representing the coefficients $Q_1\ Q_2 \ldots . Q_{12}$ is principally confirmed by the compensation of the coefficients of diametrically opposite months as shown in the following combinations.

$Q_1 = -1{,}030$	$Q_2 = -0{,}923$	$Q_3 = -0{,}623$	$Q_4 = -0{,}126$	$Q_5 = +0{,}304$	$Q_6 = +0{,}786$
$Q_7 = +1{,}000$	$Q_8 = +0{,}959$	$Q_9 = +0{,}659$	$Q_{10} = +0{,}131$	$Q_{11} = -0{,}391$	$Q_{12} = -0{,}836$
sum $= -0{,}030$	$= +0{,}036$	$= +0{,}036$	$= +0{,}005$	$= +0{,}003$	$= -0{,}050$

From the observations now produced and from the fact, that the coefficients Q_m according to the formula $\frac{t_m - M}{t_7 - M}$ represent abstract numbers, independent of the thermometrical scale employed and of the geographical position, it follows, that the coefficients Q_m evidently are chiefly composed of dynamo-cosmical factors. After some lengthened considerations it was finally concluded, that the coefficients Q_m are proportionate to the thermo-cosmical position referred to the chronological or geometrical centre of the month concerned, and expressed in ratio to $Q_7 = 1{,}0000$, and the thermo-cosmical position defined by the suns distance, the number of days of the month, and the altitude of the sun, corresponding to the thermal retardation and the observed displacement of the months.

If now P_m denotes the thermo-cosmical position referred to the centre of the months m, then the determinating factors are analytically expressed thus

$$P_m = \frac{m}{d_m^2}\ sin\ \omega\ sin\ (L_m - R_m),$$

or according to the second of Keplers laws more conveniently and more precise by

$$P_m = V_m\ m\ sin\ \omega\ sin\ (L_m - R_m) \quad . . \quad . . \quad (8),$$

in which

V_m denotes the mean angular velocity of the earth in the month m,
m the number of days in the month m,
ω the mean obliquity of the Ecliptic,
L_m the longitude of the sun at the chronological centre of the month m, and
R_m the effect of the absorption represented by a retardation in the longitude of the sun for the month m.

In the following paragraphs the formula (8) and the elements of the same are discussed and numerically determined.

Definition, numerical value and stability of the thermal, dynamo-cosmical factor Q_m.

20. The principal difference in respect to exactness in astronomical as compared to meteorological matters has already at several occasions been commented upon, but perhaps the place to repeat the same is just before the attempt is made to settle the numerical value of the factors, which constitute the thermo-cosmical position for each month according to the definition of the formula (8). Already this definition indicates a certain approximation, not in the sense of any arbitrary evaluation or for the sake of convenience, but in order to provide for numericals, possessing full validity for periods of considerable duration; with this object in view, in the Authors opinion of more weight than a momentary precision, the astronomical data, originally taken from the Greenwich nautical almanac and astronomical ephemeris for the years 1891 and 1892, have been regulated and to a certain extent transformed to suit the thermo-cosmical formulæ and purposes.

The solar-year.

First of all it must be named, that for the determination of the numericals of the special factors in the formula (8) the solar-year is made to replace the calendar-year, for which and its divisions all the data in the ephemeris are calculated. By the substitution of the solar-year, not only an excellent corrective for the precision of the two first named factors in the formula $(V_m\ m)$ is obtained, but the apparent irregularities in the earths motion, due to the incommensurability of the solar- and the calendar-year, are removed, and then the earths place in the orbit, once determined for the chronological centres of the months, is not affected by the regulations, caused by the recurrent leap-years. Therefore the introduction of the solar-year grants more stability to the thermo-cosmical factors, in fact, considering the duration of the secular perturbations, — the periodical are too small to require notice — the factors regulated for the solar-year may be taken to remain in force for any period to come. The following notes from the Greenwich ephemeris, Mädler and other authorities are in this respect of interest.

Eccentricity, at present = $0{,}_{01677}$, limits $0{,}_{00}$ to $0{,}_{06939}$, period = 33200 years; decreases at present $0{,}_{00042}$ in 1000 years.

Suns distance. Mean distance = 20,120000 geographical miles; max. = 20,450000 g. M. at the 3rd of July, min. = 19,790000 g. M. at the 1st of January.

Solar-year = $365{,}_{24224}$ days; decreases at present $0''{,}_{539}$ in one hundred years; Period = 21000 years.

Velocity in the orbit. Mean velocity = $59'{,}_{1388}$; max. at the Perigee = $61'{}_{168}$, min. at the Apogee = $57'{,}_{195}$.

Perigee, 1st of January 1891, longitude = $280^\circ\ 50'{,}_2$ | Period 21000 years,
Apogee, 3rd of July 1891, longitude = $101^\circ\ 13'{,}_2$ | Advances one day in 58 years.

Mean obliquity of the Ecliptic, 1891 = $23^\circ\ 27'{,}_{26}$, decreases annually $0''{,}_{476}$; limits $21^\circ\ 58'\ 36''$ and $24^\circ\ 35'\ 58''$; Period = 40350 years.

The unit of time is in the formula referred to Greenwich meridian. The max. of difference from local time means in the formula a passage of 12 hours, and the

max. of error in longitude of the sun does therefore not exceed $\pm$ $0^0,5$; when reduced to mean altitude of the sun this error is scarcely noticeable, and the introduction of conventional meridians or zone-times for the different continents would therefore as far as regards the thermo-cosmical factors be of little or no consequence.

All the regulations of the Greenwich data are applied through the medium of the mean velocity, the most constant of the astronomical elements and the least variable in the orbit, the extreme difference in the angular velocity, in the Perigee and the Apogee, being less than 4 Min.

Including some minor corrections the mean velocity in the months of the solar-year is determined as follows:

	number of days	mean velocity	length of curve
January	31	$61',073 = 1^o,0179$	$31^o\ 33',260$
February	$28,24224$	$60',561 = 1^o,0093$	$28^o\ 30',376$
March	31	$59',679 = 0^o,9947$	$30^o\ 50,,077$
April	30	$58',661 = 0^o,9777$	$29^o\ 19',827$
May	31	$57',797 = 0^o,9633$	$29^o\ 51',703$
June	30	$57',292 = 0^o,9549$	$28^o\ 38',757$
July	31	$57',265 = 0^o,9544$	$29^o\ 35',211$
August	31	$57',726 = 0^o,9621$	$29^o\ 49',503$
September . .	30	$58',561 = 0^o,9760$	$29^o\ 16',827$
October	31	$59',575 = 0^o,9929$	$30^o\ 46',821$
November . .	30	$60',498 = 1^o,0083$	$30^o\ 14',937$
December	31	$61',055 = 1^o,0176$	$31^o\ 32',701$
the year =	$365,24224$	$= 59',1388 = 0^o,9856$	$= 360^o$

In the Greenwich ephemeris of 1891 and 1892 (leap-year) the longitude of the sun is given

at January $1891,_0$	$= 280^o\ 19'\ 37'',45$	and at January $1892,_0$	$= 280^o\ 4'\ 49'',05$
— $1892,_0$	$= 280^o\ 4'\ 49'',05$	— $1893,_0$	$= 280^o\ 51'\ 26'',90$
Regulation	$+ 14'\ 48'',40$	Regulation	$- 46'\ 37'',85$

On intercalating now for February 1891 the missing $0,24224$ days and the corresponding length of curve $= 14'\ 34'',68$ the longitude April $1891,_0$ was regulated to $11^0\ 13'\ 44'',33$ $= 11^0\ 13',739$; starting from this point, and operating with the mean velocity stated above, the longitude of the sun, or the term L_m in the formula (8), is determined for the chronological centre of each month in the solar year as follows:

Chronological centre of the month	Longitude of the sun (L_m)	Δ
January	296° 6′,66	30° 1′,81
February	326° 8′,47	29° 40′,23
March	355° 48′,70	30° 4′,95
April	25° 53′,65	29° 35′,77
May	55° 29′,42	29° 15′,23
June	84° 44′,65	29° 6′,98
July	113° 51′,63	29° 42′,36
August	143° 33′,99	29° 3′,16
September . .	172° 37′,15	30° 31′,83
October	203° 8′,98	30° 30′,88
November . .	233° 39′,86	30° 53′,82
December	264° 33′,68	31° 32′,98
(January	296° 6′,66)	
	the year =	360°

The term $sin\ \omega$ might be omitted from the formula as the same appears in the numerator as well as in the denominator of the proportion $\frac{P_m}{P_7}$, but it seems correct to maintain the same for the conversion of the suns longitude to altitude, the latter function being that, which really enters into the calcule. The mean obliquity of the Ecliptic (ω) is in the formula put down to 23° 27′,26.

The retardation.

Of the terms, exposed in the formula (8), the retardation ($-R_m$) still remains undecided. The retardation represents in the dynamo-cosmical formula a function of physical nature, as the term ($-R_m$) is equal in time to that delay in the full development of temperature, which is the consequence of the absorption by the earths surface of the heat, emanating from the sun. The duration of this delay, converted in the proportionate movement of the earth, or in the retardation of the suns longitude, gives, when introduced in the formula, that position of the sun from which the rays of heat are imagined to emanate and act physically in all respects equal to the rays of light. The absorption is thus converted into a dynamo-cosmical process.

The effect of absorption, it should be noted, is marked by the fact, that the highest temperature in the year is not attained in the month of June (including the summer-solstitial) but in July, and the effect of the phenomenon is also known from daily experience, as the highest temperature of the day does not follow at noon, but generally a few hours later.

The following arguments may perhaps approach a provisional answer to the question of the duration of the delay in the yearly movement of temperature caused by the absorption. If the retarded solstitial point be defined as that position, in which the temperature of the day reaches its maximum, it follows, that this point must be placed between the middle and the end of July; it cannot be placed in the centre of July, as this would render August equal in temperature to June (too early), and it cannot be

found at the end of July, which would give to July and August equal temperature (too late); — none of these positions agree therefore with the statistical experiences, named in the beginning of this part. Consequently the thermal solstitial is to be placed between the middle and the end of July, and the duration of the retardation approximately put down to about one month.

Considered from a dynamo-cosmical point of view the time of the delay is always constant and representing the mean absorption by the earths surface; if now the velocity in 2 consecutive months is about the same, which is the case in June and July, then the approximate amount of retardation may be found by an experiment made with the north-american coefficients Q_m, the result of which at that early period was felt as a great point of support in these reflections. From the preceding tables and from the ephemeris (1891) we have namely

$$\left.\begin{aligned} Q_6 &= 0{,}_{786} \\ Q_7 &= 1{,}_{000} \end{aligned}\right\} \text{ and } \left\{\begin{aligned} L_6 &= 84^0\,3',_4 \\ L_7 &= 113^0\,8',_5 \end{aligned}\right.$$

and consequently the approximate proportion

$$sin\ \omega .\ sin\ (84^0\,3',_4 - x) : sin\ \omega .\ sin\ (113^0\,8',_5 - x) = 0{,}_{786} : 1{,}_{000},$$

from which

$$tg\ x = \frac{0{,}_{786}\ sin\ 113^0\,8',_5 - sin\ 84^0\,3',_4}{0{,}_{786}\ cos\ 113^0\,8',_5 - cos\ 84^0\,3',_4} = 0{,}_{6558}$$

and $arc\ tg\ x = 33^0\,18'$, equal to about 34 days;

this would displace the solstitial point from the 21/22 of June to about the 25th of July, which in fact agrees well with the general statistics and the above reflections.

The numerical term in the formula (8), which shall satisfy all the conditions, facts and arguments relative to the dynamo-cosmical expression for the phenomenon of absorption, takes now the definite form

$$R_m = -\,30{,}_{43485}\ \frac{V_m + V_{m-1}}{2},$$

in which the constant factor is equal to $^1/_{12}$ of the solar-year, whilst $\frac{V_m + V_{m-1}}{2}$ represents the mean velocity of the month m and that of the preceding month, and R_m the total retardation, or the length of the curve traversed during the process of absorption. From these data the retardation is calculated for each of the 12 months as follows:

January	$30^0\,58',_{57}$	Juli	$29^0\ 3',_{52}$
February	$30^0\,51',_{08}$	August	$29^0\ 9',_{90}$
March	$30^0\,29',_{89}$	September	$29^0\,29',_{63}$
April	$29^0\,58',_{88}$	October	$29^0\,57',_{76}$
May	$29^0\,32',_{27}$	November	$30^0\,27',_{24}$
June	$29^0\,11',_{46}$	December	$30^0\,49',_{80}$

total $= 360^0$.

The following table now gives the numerical value for each month of the different factors in the complete formula

$$P_m = V_m\, m\, sin\, \omega\, sin\left(L_m - 30,_{43485}\,\frac{V_m + V_{m-1}}{2}\right) \quad .. \quad .. \quad (9),$$

and the product reduced in ratio to July $= 1,_{0000}$. It will be found, that a minor correction had thereafter to be applied, which further on will be explained. The table gives then the finally resulting value of the dynamo-cosmical coefficients Q_m.

	V_m	m	$sin\, \omega$	$sin\left(L_m - 30,_{43485}\,\frac{(V_m + V_{m-1})}{2}\right)$	
January ..	$1,_{0179}$	31	$sin\, 23^0\, 27',_{26}$	$sin\,(296^0\ 6',_{66} - 30^0\, 58',_{57})$	$= -12,_{5142}$
February ..	$1,_{0093}$	$28,_{24224}$	$sin\, 23^0\, 27',_{26}$	$sin\,(326^0\ 8',_{47} - 30^0\, 51',_{08})$	$= -10,_{2581}$
March	$0,_{9947}$	31	$sin\, 23^0\, 27',_{26}$	$sin\,(355^0\, 48',_{70} - 30^0\, 29',_{89})$	$= -\ 6,_{9845}$
April	$0,_{9777}$	30	$sin\, 23^0\, 27',_{26}$	$sin\ \ (25^0\, 53',_{65} - 29^0\, 58',_{88})$	$= -\ 0,_{8315}$
May	$0,_{9633}$	31	$sin\, 23^0\, 27',_{26}$	$sin\ \ (55^0\, 29',_{42} - 29^0\, 32',_{27})$	$= +\ 5,_{2018}$
June	$0,_{9549}$	30	$sin\, 23^0\, 27',_{26}$	$sin\ \ (84^0\, 44',_{65} - 29^0\, 11',_{46})$	$= +\ 9,_{4027}$
July	$0,_{9544}$	31	$sin\, 23^0\, 27',_{26}$	$sin\,(113^0\, 51',_{63} - 29^0\ 3',_{52})$	$= +11,_{7275}$
August ..	$0,_{9621}$	31	$sin\, 23^0\, 27',_{26}$	$sin\,(143^0\, 33',_{99} - 29^0\ 0',_{90})$	$= +10,_{8105}$
September ..	$0,_{9760}$	30	$sin\, 23^0\, 27',_{26}$	$sin\,(172^0\, 37',_{15} - 29^0\, 29',_{63})$	$= +\ 6,_{9932}$
October ..	$0,_{9929}$	31	$sin\, 23^0\, 27',_{26}$	$sin\,(203^0\ 8',_{98} - 29^0\, 57',_{76})$	$= +\ 1,_{4533}$
November ..	$1,_{0083}$	30	$sin\, 23^0\, 27',_{26}$	$sin\,(233^0\, 39',_{86} - 30^0\, 27',_{24})$	$= -\ 4,_{7446}$
December ..	$1,_{0176}$	31	$sin\, 23^0\, 27',_{26}$	$sin\,(264^0\, 33',_{68} - 30^0\, 49',_{80})$	$= -10,_{1214}$

Continuation.

		Reduction in ratio to July $= 1,_{0000}$	Correction applied	Q_m
January	$-12,_{5142}$	$-1,_{06708}$	$0,_{00316}$	$= -1,_{07024}$
February	$-10,_{2581}$	$-0,_{87471}$	$0,_{00259}$	$-0,_{87730}$
March	$-\ 6,_{9845}$	$-0,_{59557}$	$0,_{00176}$	$-0,_{59733}$
April	$-\ 0,_{8315}$	$-0,_{07090}$	$0,_{00021}$	$-0,_{07111}$
May	$+\ 5,_{2018}$	$+0,_{44356}$	0	$+0,_{44356}$
June	$+\ 9,_{4027}$	$+0,_{80177}$	0	$+0,_{80177}$
July	$+11,_{7275}$	$+1,_{00000}$	0	$+1,_{00000}$
August	$+10,_{8105}$	$+0,_{92181}$	0	$+0,_{92181}$
September	$+\ 6,_{9932}$	$+0,_{59630}$	0	$+0,_{59630}$
October	$+\ 1,_{4533}$	$+0,_{12392}$	0	$+0,_{12392}$
November	$-\ 4,_{7446}$	$-0,_{40457}$	$0,_{00120}$	$-0,_{40577}$
December	$-10,_{1214}$	$-0,_{86305}$	$0,_{00256}$	$-0,_{86561}$

$$\begin{cases} +3,_{88736} \\ -3,_{87588} \end{cases} \qquad \Sigma\,(\pm\, Q_m) = \begin{cases} +3,_{88736} \\ -3,_{88736} \end{cases}$$

The correction applied makes the term $\Sigma\,(\pm\, Q_m) = 0$, which is requisite in order to satisfy the statistical series (§ 19). The total correction is equal to the difference $0,_{01148}$, appearing in the first reduction, and proportionately distributed to the 6 negative

months. This correction, however small, is one of interest, as the same is due to the well known phenomenon, the greater velocity of the earth in the negative or winter-months, which tends to disperse the ordinates from January towards the equinoctials, i. e. to reduce the sum of the negative ordinates, and which also shortens the „negative“ transit by about 7 days. — At this place it may be noticed, that the coefficients Q_m distinctly divide the solar year in two halves, the 6 positive months being May, June, July, August, September and October, and the 6 negative months January, February, March, April, November and December, or better the continuous series November—April.

21. There is a remarkable analogy between the parallel-equations, stating the normal or „solar“ climate, and the dynamo-cosmical coefficient, the main factor in the normal yearly movement of temperature. Both refer to a normal state of the order in nature, and both require therefore a supplementary local or thermo-geographical factor. But there is that distinction to be made, that the solar climate or normal temperature of the parallels remains a theoretical definition, whilst it can be proved, that the dynamo-cosmical factor is present in almost the theoretical value $\Sigma(+ Q_m) = 3{,}8874$ in all observations of temperature from the northern zones, or from 60 % of the total surface of the globe.

Statistical researches on the dynamo-cosmical term $\Sigma(+ Q_m) = 3{,}8874$.

The importance of the coefficient Q_m, not only in respect to the immediate use of the same, but for the applications, which in many directions can be made of it as the chief term in an equation, forming a direct connecting link between cosmical and terrestrial phenomena, makes it a principal duty to produce statistical evidences in support of these assertions.

For this and other purposes the Author has collected and arranged in the Tables V—VIII a suite of 381 places and 474 observations of temperature. The collection is made partly from Doves tables, but chiefly from the extensive and recent tables of temperature, given in the already mentioned standard book of references, the Challenger Reports.

Tab. V – VIII.

The Tables V—VIII contain in 11 columns the geographical position of the place, the Authority and period of observations, the mean yearly temperature, and the value of the term $\Sigma(+ Q_m^1)$, calculated from the series of monthly temperature. The tables contain, besides, the thermo-geographical coeficient MV, which further on will be treated fully and in detail. All the series of temperature are reduced to degrees Centigrade, and all places are arranged according to latitude in the order from North to South and enumerated.

Generally known places and places of moderate height and long periods were first selected, and the list then completed to fill the intervals in order to have all latitudes and meridians as much as possible equally represented; places of special interest were afterwards added to the list, or included in the special researches.

The formula employed for the statistical determination of the term $\Sigma(+ Q_m^1)$ is the followiug

$$\Sigma(+ Q_m^1) = \frac{\Sigma(+ t) - 6\ M}{t_7 - M} \quad .. \quad .. \quad (10),$$

in which $\Sigma(+ t)$ denotes the sum of the monthly observations of higher temperature than M*).

The number of places and observations are distributed in the tables as follows

		places	observations
Tab. V.	Europe and adjacent parts of Asia and Africa ..	169	226
Tab. VI.	Asia	72	87
Tab. VII.	The Atlantic, including Greenland, Iceland, the Faroe and other isles	87	96
Tab. VIII.	North-America	53	65
		= 381	474
of which are excluded as situated south of 30° lat.		18	28

This leaves a rest of 363 places and 446 observations for the special researches, respecting the northern thermo-cosmical coefficients.

It should be specially noted, that Tab. VII includes 67 observations for places in the north-atlantic ocean, which are given in the Challenger Reports and accompanied by the note „calculated from data published in the United States International Meteorological Observations“, period $5^2/_3$ years.

On glancing over the figures, given in the column 10 of the 4 tables and stating the value of $\Sigma(+ Q_m^1)$, determined as accurately as possible**) for each place and observation, the rather insignificant variation of the same, far less than of any local absolute temperature, will at once be observed. This general impression of steadiness, quite exceptional in statistics of temperature, is in a great measure confirmed by the results, obtained from a close examination and systematical classification of the said quantity.

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*) In the few abnormal cases, in which this definition did not apply to 6 but to another number of months (5—7), the term 6 M was corrected accordingly.

**) The Author refers here to the fact, or rather to the experience gained from these researches, that the meteorological statistics as a rule do not give the „means“ with the precision required in analytical investigations; the mean yearly temp. for inst. should at any rate be stated with more than one decimal; a very instructive case of this kind will be noticed later on, but the occasion is taken here to remark, that in order to secure a higher degree of precision all the mean yearly temperatures in Tab. IX had to be re-calculated from the monthly means and given with 3 dec.[1]) — During the work several misprints in the tables have been found and corrected.

[1]) Originally with 4 dec.

From the tables we find:

					$\Sigma(+ Q_m^1)$
V.	Europe	means of	224	observations	$3_{,7279}$
VI.	Asia	„	78	„	$3_{,9011}$
VII.	The Atlantic	„	91	„	$3_{,9341}$
VIII.	North-America	„	53	„	$3_{,9047}$

and the mean value of $\Sigma(+ Q_m^1)$ for the northern temperate and polar Zones . . . . . = $3_{,8669}$

that is, if the theoretical value $3_{,8874}$ be taken equal to $100_{,00}$, the above statistical value is found = $99_{,45}$.

The following classifications illustrate the geographical distribution of the places, whose coefficients more closely approach the theoretical value of $\Sigma(+ Q_m)$, ($3_{,8000}$ to $3_{,9500}$).

A.

V. EUROPE.

24.	St. Petersburg . .	$3_{,8333}$	75.	Saratow	$3_{,9522}$	113.	Gr. St. Bernard . .	$3_{,8389}$
37.	Gøteborg	$3_{,9504}$	78.	London-Greenwich	$3_{,9016}$	119.	Milano	$3_{,8542}$
51.	Moscow	$3_{,8338}$			$3_{,8077}$	120.	Kertsch	$3_{,8063}$
52.	Copenhagen	$3_{,8156}$	82.	Dresden	$3_{,8367}$	122.	Simferopol	$3_{,8377}$
		$3_{,8912}$	85.	Isle of Wight . .	$3_{,8288}$	125.	Sebastopol	$3_{,8701}$
		$3_{,9275}$	86.	Kiew	$3_{,8412}$	126.	Bukarest	$3_{,8625}$
58.	Helgoland	$3_{,8188}$	87.	Francfort	$3_{,9102}$	134.	Sophia	$3_{,8514}$
59.	Samara	$3_{,8930}$			$3_{,9014}$	136.	Rome	$3_{,8715}$
62.	Hamburg	$3_{,9196}$	93.	Poltava	$3_{,8231}$	137.	Tiflis	$3_{,8538}$
65.	Orel	$3_{,8361}$	94.	Carlsruhe	$3_{,8855}$	138.	Batum	$3_{,9051}$
66.	Berlin	$3_{,9396}$	95.	Paris	$3_{,9287}$	140.	Constantinople . .	$3_{,8861}$
70.	Valentia	$3_{,8165}$			$3_{,8804}$*)	144.	Baku	$3_{,9220}$
71.	Oxford	$3_{,9505}$	102.	Basel	$3_{,9095}$	151.	Smyrna	$3_{,8253}$
72.	Orenburg	$3_{,8931}$	109.	Klagenfurt	$3_{,8908}$	158.	Malta	$3_{,8026}$
73.	Kursk	$3_{,9176}$	112.	Astrakhan	$3_{,8085}$			

Extreme positions . . lat. 59° 56′ — 35° 53′ N. long. 10° 18′ W. — 55° 6′ E.

VI. ASIA.

2.	Werchojansk	$3_{,9239}$	24.	Irkutzk	$3_{,8298}$	32.	Blagowetschensk . .	$3_{,8501}$
6.	Jakutzk	$3_{,9517}$			$3_{,8539}$	47.	Margelan	$3_{,8476}$
8.	Olekminsk	$3_{,8554}$	27.	Akmolinsk	$3_{,8574}$	48.	Krasnowodsk	$3_{,9024}$
20.	Wercholensk . . .	$3_{,9456}$	28.	Selenjinsk	$3_{,9509}$	54.	Niigata	$3_{,9314}$
21.	Barnaul	$3_{,8910}$	30.	Semipolatinsk . .	$3_{,8356}$	57.	Tokio	$3_{,8636}$
22.	Nicolajewsk	$3_{,9407}$	31.	Kjachta	$3_{,9543}$	64.	Zeikiwey	$3_{,8065}$

Extreme positions . . . . lat. 67° 34′ — 31° 12′ N. long. 52° 39′ — 140° 45′ E.

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*) This figure is calculated from M. Renous series, published in „Meteorologische Zeitschrift, Februar 1891“, and giving the revised monthly means of observations extending over a period of 120 years. The above value of $3_{,8804}$ represents therefore a case of considerable interest. — In the Journal, however, the mean monthly temperature of the whole period is given with but one decimal,

VII. THE ATLANTIC.

10.	Godthaab			3,8731	31.	52°30′	— 37°30′	3,8941	49.	42°30′	47°30′	3,9261
19.	Bermuda			3,8130	32.		32°30′	3,8835	52.		32°30′	3,9091
				3,8940	37.	47°30′	— 47°30′	3,9439	53.		27°30′	3,9028
21.	57°30′	— 47°30′		3,8384	38.		42°30′	3,8282	57.	37°30′	— 72°30′	3,9293
23.		37°30′		3,8947	39.		37°30′	3,7976	66.		27°30′	3,9306
24.		32°30′		3,9546	40.		32°30′	3,9028	69.		12°30′	3,8596
25.		27°30′		3,8625	41.		27°30′	3,8867	70.	32°30′	— 77°30′	3,9246
26.		22°30′		3,9459	47.	42°30′	— 57°30′	3,8844	74.		57°30′	3,8394

Extreme positions . . . . lat. 64° 10′ — 32° 17′ N. long. 12° 30′ — 77° 30′ W.

VIII. NORTH-AMERICA.

1.	Boothia Felix		3,7870	27.	Concorde	3,9337	35.	Pittsburg	3,9474
6.	Sitka		3,8871	28.	Albany	3,8215	38.	Sacramento	3,7970
14.	Anticosti, W.P.		3,9091			3,9470	40.	St. Louis	3,9421
15.	Anticosti, S.W.P.		3,9312	30.	Chicago	3,9055	42.	Cairo	3,8505
17.	St. Johns, N.F.		3,8117	32.	Omaha	3,9117	43.	Santa Fé	3,8706
21.	Fredericton		3,9300	34.	New York	3,9116	45.	Memphis	3,8769
26.	Toronto		3,9508			3,9144		

Extreme positions . . . . lat. 69° 59′ — 35° 9′ N. long. 52° 42′ — 135° 18′ W.

As a general result of these comparisons it may be pointed out, that the percentage of the number of coefficients, placed within the above narrow limits of the theoretical value, amounts to

V.	Europe	19,7 %	VII.	The Atlantic	26,4 %
VI.	Asia	21,8 %	VIII.	North-America	37,7 %

Although taken from a moderate number of observations the proportion strikingly confirms the effect of the geographical position of North-America mentioned before, which induced the Author to try to obtain a clue to the leading factors in the movement of temperature by the aid of observations from this continent.

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and from these means we have $\Sigma(+ Q_m^1) = 3{,}8580$, but if the monthly means of the 12 decennials, in which the period is divided, are taken with 2 dec., the above and more correct value of $\Sigma(+ Q_m^1) = 3{,}8804$ is found. This obs., referred to above, manifest the necessity of exact statistical means, if these be taken as arguments or proofs of analytical researches.

In respect to latitude a general classification of the total number of observations (446) has given the following means of $\Sigma(+Q_m^1)$,

B.	V Europe	VI Asia	VII The Atlantic	VIII N. America	Means
means of observations to 60° lat. . . .	3,4933	3,6305	3,9065	3,6767	3,6768
60° to 55° lat. .	3,6385	3,7437	4,0543	3,8591	3,8239
55° - 50° lat. .	3,7683	3,8825	3,9063	3,8941	3,8603
50° - 45° lat. .	3,7759	4,0159	3,8730	3,8754	3,8851
45° - 40° lat. .	3,7371	4,0092	3,9052	3,8949	3,8866
40° - 30° lat. .	3,9378	4,0382	3,8449	4,1935	4,0036

The groups A and B complete each other and give, together with the tables V—VIII and the means of the same, the required statistical proofs of the uniform force, with which the dynamo-cosmical coefficient marks its presence in the movement of temperature all over the temperate and polar zone of the northern hemisphere; the theoretical value of the quantity $\Sigma(+Q_m) = 3{,}8874$ may therefore be taken as a true realization in the most concentrated form of Humboldts auspicious words in the motto, heading this essay.

The statistical data are sufficient in number to yield a well defined average, but even therefore it seems a hazardous task to trace the nature of questionable powers. which possibly may have a tendency to modify the rational conditions. The deviations from the normal numerical elements are too small to call for corrections, and the statistics at present too incomplete to decide in such distinctions, particularly not, when it is taken into consideration, that the theoretical coefficients or fair approximations to the same are present even in extreme regions.

From all the analytical as well as statistical investigations it may then be concluded, that the formula (9), representing the monthly normal *force, duration* and *direction* of the thermo-cosmical powers, is complete in that sense, that no element or factor of any traceable influence has been omitted.

22. Of the statistical details the before mentioned calculated temperature of positions at regular intervals across the north-atlantic ocean deserve special notice; in the Challenger Reports no information respecting this calcule is given, but from the above classification it will be seen, that exactly $^1/_3$ (21) of the total number (63) comes within the limits prescribed for the formation of group A, a proportion, which seems to confer to the north-atlantic series a value not very far from those acquired by regular observations.

23. The researches afford valuable contributions in regard to questions relating to the movement of temperature in higher regions; the following extract of the Tables V—VIII, showing the value of the coeff. $\Sigma(+ Q_m^1)$ in observations from places situated in moderate as well as considerable heights and in all quarters of the three continents, will be of interest.

V. EUROPE.

19.	Røraas	629	metres	$3_{,7591}$	100.	Munich	529	metres	$4_{,0126}$
									$3_{,6776}$
107.	Bern	573	„	$3_{,5556}$	134.	Sophia	538	„	$3_{,8514}$
108.	Chur	590	„	$3_{,9929}$	142.	Alexandropol	1470	„	$4_{,1367}$
109.	Klagenfurt	438	„	$3_{,8908}$	143.	Madrid	655	„	$3_{,2628}$
110.	Obirgipfel	2044	„	$3_{,3910}$	145.	Eriwan	985	„	$4_{,1945}$
113.	Gr. St. Bernard	2480	„	$3_{,8389}$	164.	Jerusalem	732	„	$4_{,9546}$
				$3_{,5641}$					
121.	Stawropol	585	„	$3_{,7652}$					

VI. ASIA.

20.	Wercholensk	472	metres	$3_{,9456}$	35.	Urga	1311	metres	$3_{,9690}$
24.	Irkutsk	468	„	$3_{,8298}$	40.	Wjernoje	744	„	$4_{,1758}$
				$3_{,8539}$	46.	Taschkent	462	„	$3_{,6328}$
26.	Nertschinsk	660	„	$4_{,1542}$	48.	Margelan	610	„	$3_{,8476}$
				$4_{,0124}$	50.	Samarkand	725	„	$3_{,5802}$
28.	Selenjinsk	570	„	$3_{,9509}$	66.	Quetta	1677	„	$3_{,7165}$
31.	Kjachta	718	„	$3_{,9543}$					

VIII. NORTH-AMERICA.

11.	Qu'Appelle	645	metres	$4_{,3581}$	25.	Mount Washington	1914	metres	$4_{,0365}$
12.	Medicine Hat	651	„	$4_{,0495}$	33.	Salt Lake City	1326	„	$3_{,4265}$
20.	Bismarck	516	„	$3_{,9620}$	43.	Santa Fé	2167	„	$3_{,8706}$

The examination of these numericals shows clearly, that the movement of temperature within the above limits of height follows the general laws as far as the dynamo-cosmical factors are concerned.

Special notes in reference to the dynamo-cosmical factors.

24. In praxis the mean yearly temperature is approximately determined by the means of the temperature of January and July. The normal value of the coefficients Q_m shows, that a much nearer approximation may be found by taking the means of the months of March and September. The Table IX gives many examples of the good results obtained by this rule.

25. The retardation displaces the time of the equinoctials and solstitials and generally the astronomical seasons of the year for about 30 days; the retarded solstitials and the formulæ fix the $21{,}_0$ of July and the $21{,}_3$ of January as the normal date, respectively of the warmest and coldest day of the year.*)

26. The mean velocity of the earth affords a convenient scale for determining the changing effects of the sun-rays, according to the difference in the solar distances. If 100 represents the calorific power of the sun in July, when the same is a minimum, the corresponding figures in the different months are equal to

January	$106{,}_6$	July	$100{,}_0$
February	$105{,}_8$	August	$100{,}_8$
March	$104{,}_5$	September	$102{,}_3$
April	$102{,}_4$	October	$104{,}_0$
May	$100{,}_9$	November	$105{,}_6$
June	$100{,}_1$	December	$106{,}_6$

There is consequently a difference of about 7 % in favour of the winter-months (January—December) as compared with June—July. It is of interest to note, that this thermal condition changes to the reverse in the course of about 10,000 years; and consequently the seasons would then show more extreme temperatures, were it not for the contrary effect of the decrease of the obliquity of the Ecliptic, which takes place in the same period. The compensation produced by the combined effect of these perturbations tends therefore again to strenghten the stability**) of the coefficients far beyond the present epoque.

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*) The highest and lowest temperatur in the year is found

	highest temp.	lowest temp.
1. according to 130 years obs. at Paris (M. Renou)	+20,2 °C on the 18th of July	+1,5 °C on the 10th of January.
2. according to the Francfort experiment	+19,1 °C in the period of 17—28th of July	−0,5 °C, period 8—13th of January.
3. acccording to 25 years obs. at Copenhagen	+16,9 °C — of 20—24th of July	−0,5 °C, — 16—20th of January.

**) The question of stability of the equations is a most important one, and the inquiries about the same are therefore taken up occasionally, and more especially in part IV of these researches, where the complete formulæ are discussed in general.

The supplementary thermo-geographical coefficient *MV*.

27. The variable difference $(t_7 - M)$, appearing in the formula (7), proves, that the yearly movement in the temperature of a place not exclusively is regulated by the yearly motion of the earth, but that local factors are at work by the determination of as well the normal monthly as the normal yearly temperature. Consequently, either the term $(t_7 - M)$ or the normal temperature of July has to be determined in order to complete the formula.

At first sight the most direct proceeding would seem to be the introduction of any analytical or combined method, by which the normal temperature of the month of July*) may be determined; but after lengthened reflections and attempts it was found, that this difficile problem, to great advantage for the correctness and simplification of the formula, might be converted into investigations on the local mean variation of the series, representing the mean monthly temperature or the yearly movement in the temperature of the place. Now, the general formula for determining the mean variation (MV)**) in any series of observations, referred to the arithmetical mean (M) of the same,

$$MV = \frac{2\,(S - m\,M)}{n},$$

is in the case of the series of temperature simplified, and takes the form

$$MV = \frac{\Sigma\,(+\,t) - 6\,M}{6} \quad \ldots \quad (11),$$

in which the quantities S and m, according to the preceding investigations, are substituted by the sum of temperature $(\Sigma\,(+\,t))$ of the months (6), which normally have a higher temperature than M, the mean yearly temperature of the place; the coefficient $\frac{2}{n}$ is in the series of temperature always $= \frac{1}{6}$.

Now we have for normal series

$$\Sigma\,(+\,Q_m) = \frac{\Sigma\,(+\,t) - 6\,M}{t_7 - M} \quad \ldots \quad (10),$$

and

$$MV = \frac{\Sigma\,(+\,t) - 6\,M}{6} \quad \ldots \quad (11);$$

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*) The equation and formulæ for the year might in a modified form be found applicable for the determination of the temperature of July or any other month. This method opens a prospect of control and may deserve attention.

**) The mean variation (MV) certainly deserves to be more generally applied in statistical researches; the function in the above simple form marks the difference of series, which by the arithmetical means often, but erroneously, are placed on equal terms.

consequently

$$t_7 = \frac{6\ MV}{\Sigma\,(+\ Q_m)} + M,$$

which, being substituted in (7), gives the equation of the normal monthly temperature

The complete equation of the normal mean monthly temp. of places, situated in the northern temperate and polar zone.

$$t_m = MV\ \frac{6\ Q_m}{\Sigma\,(+\ Q_m)} + M \quad .. \quad .. \quad (12).$$

In the Codification the terms Q_m and $\frac{6\ Q_m}{\Sigma\,(+\ Q_m)}$ of the formula (12) are given for each month together with the logarithms. On examining the formula it will be found, that the same satisfies the statistical requirements, as the complete series of temperature determined by the formula exactly re-produces the fundamental factors MV, Q_m, $\Sigma\,(+\ Q_m)$ and M.

The formula (12) gives besides the following simple rule for the determination of the amplitude or the largest difference of temperature in any series; the same is determined by

The annual amplitude of temperature.

$$(t_7 - t_1) = \left(MV\ \frac{6}{\Sigma\,(+\ Q_m)} + M\right) - \left(MV\ \frac{6\ Q_1}{\Sigma\,(+\ Q_m)} + M\right)$$
$$= 3{,}_{1954}\ MV \quad .. \quad .. \quad (13);$$

the amplitude of the series of temperature of any place in the northern temperate and polar zone is consequently independent of the mean yearly temperature of the same.

From the formula (13) it is evident, that the coefficients MV follow that course, which in meteorological researches is attributed to the thermal amplitude of the places (jährliche Wärme-Schwankung), and usually represented graphically after the same principle as the isothermal lines themselves. There is that distinction to be observed, that MV is a function of the year and therefore more precisely determined, than terms founded on bi-monthly observations. This remark also applies to the difference $(t_7 — M)$, which partly for this reason was substituted by the annual function MV, as stated above *).

The formula (12), it should be expressly noted, is now composed exclusively of annually and theoretically determined factors, and MV is besides, as shown in the special researches part V, in possession of qualities, which give to this factor a special value in analytical determinations of the normal monthly temperature.

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*) The deviations of the term $\Sigma\,(+\ Q_m^1)$ (Tab. V—VIII) from the theoretical value $= 3{,}_{8874}$ are no doubt partly due to uncertainties or oscillations in the temp. of July.

Statistical and geographical observations and researches on the movement of the thermo-geographical coefficient MV over the northern hemisphere.

28. The thermo-geographical or physical coefficient MV is the local factor, supplementing the dynamo-cosmical coefficients Q_m and $\Sigma(+Q_m)$; the latter and MV are both statistically**) ascertained and given for the same places named in the Tables V—VIII. On referring to these tables it will immediately be observed, that whilst the coeff. $\Sigma(+Q_m)$, in consequence of its origin, shows a strongly marked tendency to assume the same value all over the temperate and polar zones, the coeff. MV is found to vary in a distinct manner with the geographical position of the place. In order to examinate more closely this variation an abstract from the tables V—VIII is made, and the places, according to the longitude, arranged in sections through the continents, Europe and Asia forming one group, North-America another one. On the following pages this scheme is completed in 10 sections through Europe and Asia, showing the progressive order of the coefficient MV in the latitudes of 60^0—55^0—52^0—49^0—44^0—35^0 and 30^0, and the supplementary 70^0 and 65^0; and in 6 sections through North-America in the latitudes 57^0—49^0—45^0—40^0—35^0 and 30^0. In the schemes the longitude of the place is given, the latitude being about that assigned for each section. In the following supplementary coefficients from the Atlantic zones and other places are added to the above.

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*) Most of the places are taken from the Challenger Reports, in which the observations of temperature are given in degrees Fahrenheit; as far as $\Sigma(+Q_m^1)$ is concerned this quantity requires no reduction, but the coefficient MV is determined and simultaneously reduced to degrees Centigrade by the formula $MV = \frac{\Sigma(+t) - 6M}{10{,}8}$. — It should further be observed, that in the schemes (on the next pages) the value of MV for a number of places is given as means of several observations.

SCHEME SHOWING THE PROGRESSIVE ORDER OF THE THERMO-GEOGRAPHICAL COEFFICIENT MV.

SECTIONS THROUGH EUROPE AND ASIA.

lat. c. 60°		MV.	*lat. c. 60°*		MV.
—6° 23′	Stornoway	3,01	49° 41′	Wjatka	10,12
5° 20′	Bergen	4,66	50° 51′	Ust-Syssolsk	9,48
7° 27′	Mandal	5,55	56° 16′	Perm	10,38
10° 43′	Christiania	7,06	68° 16′	Tobolsk	11,68
13° 30′	Carlstad	6,84	80° 16′	Narym	12,49
17° 38′	Upsala	6,83	92° 6′	Enissejsk	12,81
18° 4′	Stockholm	6,87	108° 35′	Banscht-schikowa	14,96
21° 52′	Åbo	7,50	120° 26′	Olekminsk	17,03
28° 26′	Wiborg	7,64	129° 45′	Jakutsk	19,72
30° 16′	St. Petersbg.	8,61	142° 40′	Ochotsk	12,30
31° 18′	Novgorod	8,54			

SECTIONS THROUGH EUROPE AND ASIA.

(Continued)

lat. c. 55°

		MV.
—4° 18′	Glasgow	3,68
—3° 10′	Edinburg	3,78
8° 24′	Fanø (Esbjerg)	5,45
8° 58′	Herning	5,42
10° 36′	Samsø	5,50
12° 36′	Copenhagen	5,73
14° 40′	Hammershus	5,56
21° 1′	Libau	6,63
37° 33′	Moscow	9,31
49° 8′	Kasan	10,47
60° 38′	Catharinenb.	10,51
65° 10′	St. Ssidorowa	13,02
73° 20′	Omsk	12,43
84° 58′	Tomsk	11,78
92° 49′	Krasnojarsk	12,34
105° 30′	Wercholensk	14,76
165° 55′	Berings Island	4,17

lat. c. 52°

		MV.
—10° 18′	Valentia	2,63
— 6° 21′	Dublin	3,67
— 5° 30′	Pembroke	3,18
— 1° 16′	Oxford	4,16
0° 0′	London-Greenw.	4,61
4° 53′	Amsterdam	5,28
6° 47′	Düsseldorff	5,49
9° 56′	Göttingen	5,60
12° 23′	Leipzic	6,06
13° 23′	Berlin	6,27
16° 56′	Posen	6,11
17° 2′	Breslau	6,68
21° 2′	Warsaw	7,21

lat. c. 52°

		MV.
31° 20′	Tschernigow	8,68
36° 0′	Kursk	9,25
36° 7′	Orel	9,39
45° 27′	Saratow	10,72
55° 6′	Orenburg	11,79
71° 23′	Akmolinsk	12,55
83° 47′	Barnaul	12,30
86° 2′	Ulala	11,98
104° 16′	Irkutsk	12,20
106° 53′	Selenjinsk	14,89
119° 37′	Nertschinsk	15,06
140° 45′	Nicolajewsk	12,92
158° 39′	Petropaulowsk	7,24

lat. c. 49°

		MV.
—4° 30′	Brest	3,74
2° 21′	Paris	5,25
8° 25′	Carlsruhe	6,02
9° 11′	Stuttgart	5,97
11° 34′	Munich	6,74
16° 22′	Vienna	6,95
19° 2′	Buda-Pest	7,54
24° 1′	Lemberg	7,19
34° 38′	Pultava	9,20
48° 2′	Astrakhan	9,98
51° 55′	Gurjew	10,99
61° 16′	Irgis	13,23
80° 13′	Semipolatinsk	13,05
106° 35′	Kjachta	13,62
106° 50′	Urga	13,05
127° 38′	Blagowetsch.	14,51
135° 7′	Chaborowka	14,41
142° 7′	Due	10,11

lat. c. 44°

		MV.
— 0° 35′	Bordeaux	5,28
3° 5′	Clermont	4,96
3° 53′	Montpellier	5,71
4° 49′	Lyon	5,94
7° 11′	Gr. St. Bernard	5,08
8° 55′	Genoa	5,25
9° 11′	Milano	6,99
13° 50′	Pola	5,84
14° 17′	Obirgipfel	4,96
14° 18′	Klagenfurt	7,75
24° 9′	Hermanstadt	7,56
26° 5′	Bukharest	8,09

lat. c. 44°

		MV.
33° 31′	Sebastopol	6,69
34° 5′	Simferopol	6,79
36° 29′	Kertsch	7,82
41° 59′	Stawropol	7,43
50° 15′	Alexandrowsky	9,30
62° 7′	Kasalinsk	11,86
76° 53′	Wjernoje	11,21
131° 54′	Wladiwostock	10,49
132° 21′	Askold	10,08
135° 20′	Olga	9,71
141° 23′	Sappora	8,59

SECTIONS THROUGH EUROPE AND ASIA.

(Continued.)

		lat. c. 40° *MV.*			*MV.*	*lat. c. 35°*		*MV.*
—9° 8′	Lisbon	3,50	44° 30′	Eriwan	9,98	—5° 47′	Tangier	3,56
—3° 42′	Madrid	6,31	44° 47′	Tiflis	7,57	—5° 20′	Gibraltar	3,69
—0° 23′	Valencia	4,69	49° 50′	Baku	7,44	3° 4′	Algiers	4,21
2° 37′	Palma	5,01	52° 39′	Krasnowodsk	8,17	14° 30′	Malta	4,29
8° 44′	Ajaccio	4,70	61° 5′	P. Alexandrowsk	10,64	24° 0′	Candia	4,86
9° 0′	Cagliari	4,76	66° 57′	Samarkand	8,12	35° 54′	Beyrouth	4,37
12° 29′	Rome	5,55	69° 16′	Taschkent	8,49	53° 35′	Ashur-Ade	7,58
14° 15′	Naples	5,19	71° 43′	Margelan	9,58	71° 37′	Peschavar	7,24
19° 33′	Corfu	5,31	116° 28′	Pekin	9,95	135° 46′	Kioto	7,72
23° 23′	Sophia	7,92	117° 16′	Tientsin	9,65	139° 45′	Tokio	7,08
28° 59′	Constantinople	5,86	117° 40′	Taku	9,80			
39° 45′	Trebisonde	5,61	140° 44′	Hakodate	7,33			
41° 38′	Batum	5,71	141° 59′	Miyako	6,97			
43° 49′	Alexandropol	8,96						

lat. c. 30°		*MV.*	*lat. c. 70°*		*MV.*	*lat. c. 65°*		*MV.*
—9° 44′	Mogadore	3,64	18° 58′	Tromsø	4,75	7° 45′	Christiansund	4,25
31° 17′	Cairo	5,35	23° 17′	Bosekop	6,60	14° 24′	Bodø	5,05
32° 18′	P. Said	4,13	25° 13′	Kistrand	5,99	17° 0′	Stensele	8,75
35° 13′	Jerusalem	5,10	25° 22′	Gjæsvær	4,68	23° 29′	Haparanda	8,60
50° 49′	Bushire	5,86	31° 7′	Vardø	4,71	24° 9′	Torneå	9,57
67° 3′	Quetta	6,68	33′ 1′	Kola	7,80	25° 8′	Uleåborg	8,49
71° 33′	Mooltan	6,87	133° 51′	Werchojansk	21,62	34° 39′	Kem	8,19
74° 20′	Lahore	6,82	138° 24′	Ustjansk	16,64	40° 32′	Archangel	9,16
114° 19′	Hankow	8,02				44° 16′	Mesen	8,97
121° 26′	Zeikiwey	7,65				65° 4′	Beresow	11,42
121° 28′	Shanghai	7,80				66° 35′	Obdorsk	11,40
129° 52′	Nagasaki	6,75				87° 38′	Turuchansk	12,53

SECTIONS THROUGH NORTH-AMERICA.

lat. c. 57°		*MV.*	*lat. c. 49°*		*MV.*			*MV.*
—170° 18′	St. Pauls Island (Berings sea)	4,00	—122° 53′	Olympia	4,26	—80° 45′	Moose Factory	11,45
			—122° 37′	Fort Vancouver	4,95	—64° 30′	Anticosti, WP.	8,36
—166° 31′	Ilinlik Harbour	3,81	—110° 37′	Medicine Hat	10,61	—63° 16′	Anticosti, SWP.	7,94
—135° 19′	Sitka	4,40	—103° 42′	Qu'Appelle	12,51	—55° 22′	Belle Isle	7,29
— 92° 28′	York Factory	14,30	— 97° 7′	Winnipeg	12,91	—52° 42′	St. Johns, NF.	6,21
— 61° 41′	Nain	9,63						

SECTIONS THROUGH NORTH-AMERICA.

(Continued.)

lat. c. 45°		*MV.*			*MV.*	*lat. c. 40°*		*MV.*
—100° 36′	Bismarck	11,04	—122° 59′	Fort Ross	1,91	—90° 12′	St. Louis	8,22
— 93° 3′	St. Pauls	10,49	—122° 26′	San Francisko	1,53	—87° 38′	Chicago	8,51
— 73° 33′	Montreal	10,13	—121° 30′	Sacramento	4,69	—81° 30′	Marietta	7,13
— 71° 18′	M. Washington	8,13	—111° 54′	Salt Lake City	7,88	—80° 2′	Pittsburg	7,98
— 71° 12′	Quebec	10,30	— 95° 56′	Omaha	9,54	—77° 2′	Washington	7,98
— 66° 38′	Fredericton	9,35	— 95° 43′	Council Bluffs	9,86	—74° 0′	New York	8,05
— 63° 36′	Halifax	7,51						

lat. c. 35°		*MV.*	*lat. c. 30°*		*MV.*
—117° 10′	San Diego	2,69	—94° 47′	Galveston	5,38
—105° 57′	Santa Fé	7,27	—90° 4′	New Orleans	5,02
— 90° 3′	Memphis	7,08	—82° 1′	Punta Rassa	3,16
— 79° 56′	Charleston	5,73	—81° 27′	St. Augustine	4,17
— 75° 30′	Cape Hatteras	6,08			

Although of limited contents, the tables and schemes open up a prospect of most interesting and extensive thermo-geographical studies, and the present contributions may also in time, when completed, allow a geographical representation of symmetrically arranged series of values of this factor, admitting of correct interpolations, and eventually followed by formulæ, based upon and re-producing revised and extensive statistical facts. In the Authors opinion, the present and the special researches in part V of this essay are furthermore as many arguments proving the probability of obtaining very simple and exact formulæ for the analytical determination of this interesting factor.

It would, however, lead too far and require much more statistical material, than has been at the Authors disposal, to follow for each parallel, and refer in details, the remarkable regularity in the march of the coefficient *MV* from the oceans, increasing slowly and with few, not less notable exceptions towards the centres of the continents. The distance from the oceans evidently forms the most prominent feature in the movement of this factor, but besides this, the existence or non-existence and nature of currents, and the depth of the oceans and large inland seas, set their marks, not only in the coefficients of places in the immediate proximity of the shores, but also in places far from the same. In other words, the accumulation (absorption)*) and transport of heat are those qualities of the waters, which chiefly modify the distribution and the movement of temperature, the relative power of which are numerically determined

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*) In the Challenger Reports it is stated, that the observations have shown the heating effect of the sun to be distinctly appreciable to a depth of 500 feet (over 150 metres) below the surface of the sea. — On the continents the intensity of the daily oscillations of temperature ceases to be measurable about 4 feet or a fraction over 1 meter below the surface of the soil.

respectively by the thermo-geographical component of the mean yearly temperature and by the physical coefficient *MV*. This conclusion is proved by the tables, the sections through the northern continents, and the maps and plans, on which the thermo-geographical elements are inscribed. The following sketch may convey a general view of the movement of the function *MV* over the temperate and polar zones of the northern hemisphere.

In *the Atlantic middle-zones* the principal effect of the Atlantic Ocean and the Gulf-stream is found in the following places:

	MV		*MV*
Thorshavn (the Faroe Isles) ..	2,64	Valentia (West of Ireland)	2,63
North Unst (the Shetlands)	2,54	Pembroke (West of England) ..	3,18
Stornoway (West of Scotland) ..	3,01	Falmouth (West of England) ..	3,11

Calculated from the formerly mentioned tables of temperature, given in the Challenger Reports, the lowest values of *MV* are found in about 18° W. long., decreasing from the parallel 57° 30′ (2,68) to 32° 30′ (2,17); from these points the coefficients increase slowly to about 3,00 eastwards to the coast of Europe, and westwards

in lat. 57° 30′	to about 33° W.	in lat. 42° 30′	to about 38° W.
52° 30′ -	— 38° W.	37° 30′ -	— 43° W.
47° 30′ -	— 38° W.	32° 30′ -	— 63° W.

With exception perhaps of the lat. 32° 30′ N., the above values of the coeff. *MV* agree well with the general course of the Gulf-stream.

In the second line, and particularly marking the effect of branches of the Gulf-stream, we find in northerly direction the *MV* of places on the coast of Iceland:

Grimsey (North)	3,53	Westmanø (South)	3,18
Berufjord (East)	3,54	Stykkisholm (West)	4,00,

and as far North as lat. 71° on the Isle of Jan Mayen the remarkably low coeff. 4,10. — Along the western coast of Norway, from Bergen (4,66) to Vardø (4,71), the coefficients indicate the parallel track and almost equal action of the Gulf-stream over about 10° of latitude. — In southerly direction the observations from the west-coast of France (Brest 3,74), Spain (Santander 3,19), Portugal (Lisbon 3,50), Gibraltar 3,60, and northern Africa (Tangier 3,56, Mogadore 3,64) give similar results.

The third group of coefficients comprises the whole of the Mediterranean (mean value of *MV* about 5,00), the North and the Baltic sea, mean value of *MV* about 5,50, slightly increasing towards East and North.

From the shores of the Atlantic, and the above named branches of the same, a regular increase in the eastward movement of the coefficients takes place, but

with exceptions, in several cases probably due to statistical defects. *The Caspian Sea,* however, forms, in respect to the interruption in the progressive movement of *MV,* a most interesting and instructive example. A glance over the tables immediately shows the remarkable difference between the places situated at the northern and at the southern shores of that large inland water*). We find the value of *MV*

in the North, Gurjew	10,99	in the South, Baku	7,44
Astrakhan	9,98	Krasnowodsk	8,17
P. Alexandrowsk . .	9,30	Ashur-Ade	7,58

If these coefficients be compared to the coeff. of neighbouring places, it will be observed, that in the northern coefficients no signs of any interruption in the regular progress are traceable, whilst in the southern coefficients a remarkable depression takes place. The cause of this phenomenon must be ascribed to the considerable difference in depth of the northern and the southern part of the Caspian sea. In the North and to about off Petrowsk the depth does not exceed a few fathoms, but in the southern part the depth is all over considerable, and in the middle of the sea it amounts to 560—600 fathoms. Now, this difference in depth fully explains the difference of the coefficients; the continentality of the northern coefficients cannot in any way be broken by the thin layer of water covering the soil, whilst the absorption by the deep water in the southern part is quite sufficient to interfere with the continuity in the movement of the coefficients, and to impress upon the south-caspian climate the general oceanic effect: moderation of the heat in the summer months and of the cold during the winter.

The coefficients on the other side of the Atlantic, named above, are also regularly increasing towards the eastern coast of North-America, and form an acceptable link between the observations on land (further on to be dealt with) and the calculated data across the North-Atlantic ocean.

The coefficients along the coast of *West-Greenland* offer many points for interesting comparisons; in the southern part the coefficients from Julianehaab to Godthaab (5,19—5,27) are rather lower than those found in Denmark and in the middle of the Baltic sea, and more like several coefficients in the Mediterranean (southern Italy, Corfu etc.). — Further North, from Sukkertoppen to Jacobshavn, on both sides of the Arctic circle, the coefficients (6,27—7,63) are equal to those in New Foundland and New Scotland on about the same meridian, but some 20° more southerly. — Upernivik, the northermost of the danish settlements, on about 73° lat., gives about the same coefficient (8,72) as Chicago and Toronto in North-America and St. Petersburg at the bottom of the Gulf of Finland. — Consequently, by the combined effect of the branch of the Gulf-stream, moving northwards along the coast, and of the deep water outside the shores, the places in West-Greenland are, in respect to the annual movement of temperature, put on equal terms, respectively with places in the Mediterranean, in Denmark and in the Baltic sea and branches of the same, in advanced parts of

*) In area and configuration almost equal to Sweden.

North-America and at the great lakes in this continent. The spread of these coefficients, the number of which are easily augmented*), evidently shows, that the phenomenon of equal amplitude of the yearly movement in temperature originates in geographical and local combinations of land and water, the ensemble of which may be seen in numerous and quite differently situated places.

Concluding this sketch of the movement of the physical coefficient in the Atlantic middle-zones it remains to be observed, that particularly the experience gained from the plain and non-complicated circumstances, which regulate the numerical value of the coefficients surrounding the Caspian sea, are direct applicable to all inland seas, gulfs and fjords, and in general to all waters, not characterized with continually acting currents; the exact relation between the depth, the superficial extent and pureness of lakes and seas on the one side, and the movement in temperature, represented by the coefficient *MV*, on the other side, certainly deserves to be fully worked out, not only because a most important term in the physical Geography will be the sure gain, but also for that reason, that correct coefficients of places near the coast are of great consequence as starting points for the determination of the continental series. In the special researches, part V, this plan will be found more fully explicated. It needs scarcely be expressly noted, that by combined investigations the more complicated relation between the effect of moving waters and the temperature can be fully and numerically ascertained, and the effect of depth and current separated.

Observations in the *Pacific middle-zones* are scarce, and only places spread along the coast and islands are recorded. They are nevertheless of interest for the direct numerical comparisons of the thermal effect of the Pacific and Atlantic ocean, and the Kuro Siwo and Gulf-stream.

Starting from *Petropaulowsk* (lat. 53° N.) on the south-eastern coast of Kamschatka, we find the coefficients in the curve, described by the islands of the Kurile and Japan down to *Nagasaki* (lat. 33°), to have about the same value as the coefficients along the Atlantic coast of North-America from *Belle Isle* (lat. 52° N.) to *Cape Hatteras* (lat. 35°), as will be seen from the following scheme.

Pacific coefficients		*Atlantic coefficients*	
Petropaulowsk	7,24	Belle Isle	7,29
Sapporo	8,59	St. Johns, N.F.	6,21
Hakodate	7,33	Halifax	7,51
Miyako	6,97	Concorde	8,22
Niigata	7,43	Boston	8,00
Tokio	7,08	New York	8,05
Kioto	7,72	Washington	7,98
Shimonoseki	6,64	Cape Hatteras	6,08
Nagasaki	6,72		
	mean = 7,30		mean = 7,42

*) To the above examples may, for inst., be added south-caspian places and places in Japan and other parts of the Pacific, giving coefficients similar to those of West-Greenland.

It is in this scheme of peculiar interest to notice the coefficients of Petropaulowsk and Belle Isle; being equal, they correspond exactly to the analogical situation in the same latitude, both direct exposed to the influence from the great oceans and from a branch of the polar currents, setting south; the numerical effect of this situation is given in the two coefficients 7,24 and 7,29. — The parallelism of the rest of the two series of coefficients appears a little broken by inequalities of the coast-line and by small differences in the situation of the places, but still the conformity admits of the conclusion, that in both series the ocean and the declining polar currents regulate the movement in temperature with numerically the same effect. The places on the eastern coast of North-America from Belle Isle to Cape Hatteras occupy therefore so far a similar position as the beautiful islands of Japan.

The places in *the Berings sea,*

Berings island	4,17	St. Pauls island. . . .	4,00	Ilinlik Harbour	3,81,

appear as much influenced by the Kuro Siwo as Iceland by the Gulf stream; the analogical action of both currents is further illustrated by the coefficients of Sitka and other places along the Pacific coast of North-America, which approximate the coefficients along the coast of Norway.

On *the continental shores of the Berings sea, the Ochotsk, the Japan* and *the Yellow sea,* inside the numerous groups of islands stretching along the eastern coast of Asia, the coefficients are all of high continental value, with a modification only on the part of some places at the coast of middle China; at Shanghai and the neighbouring Zeikiwej (lat. 31 ^{0}) and Hankow*) (31 ^{0}), about 700 Km. from the coast at the deep and broad river Yangtse-kiang,. the coefficient *MV* is found reduced respectively to 7,80—7,65 and 8,02.

The absolute, as well as the relative value of *the Indian* and generally the *south-asiatic coefficients* are, as far as the temperate zone is considered, fully explained by the preceding observations; the coefficients may be taken as the continuation of the mediterranean coefficients, in the south-western part modified by the Red sea, the Persian gulf, the Black sea and the Caspian sea. The moderate continental coefficient of Bagdad (8,08 (?)), placed centrally in this region, expresses in a satisfactory manner the combined effect from all quarters. — There is perhaps occasion to note, that the geographical situation of Bagdad gives the same coefficient as the very differently situated places of New York and Hankow, and of Krasnowodsk opposite Baku at the Caspian Sea, respectively 8,08 — 8,05 — 8,02 and 8,17; this fact is strengthened by the moderate height of the 4 places, and the numerical comparisons of the effect of these

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*) The comparatively low coefficient of Hankow seems to be attributable to certain meteorological phenomena, in reports from the establishment at Zeikiwey described as consisting of strong currents continually setting in from the Pacific along the Yangtse-Kiang valley, and interrupting the free atmospheric circulation across the valley, i. e. in the direction North-South. The phenomenon is reported to cause serious disturbances in the districts North and South of the river.

situations are further simplified by the similarity of the dynamo-cosmical coefficients, resp. $4{,}_{34}$ — $3{,}_{91}$ — $3{,}_{97}$ and $3{,}_{90}$.

In the above representations and comparisons of the coefficient *MV* the movement in latitudinal direction has been the chief object; the scheme given on the following page shows *the movement of MV in 6 meridians,* one continental at about 90° W., two in the North Atlantic ocean (53° and 10° W.), and three showing the gradually increasing continentality towards East of the coefficient at the meridians 30°—80° and 133° E. — The figures in this scheme offer fresh impulses for continued studies, but the Author needs scarcely now here go further into the subject; it suffices to point out the thorough oceanic character of all the coefficients in the two atlantic series, even visible in the northermost point of West-Greenland, the equal continentality on about the central meridian of North America and on 80° long. E. through Asia, and the extreme value of the coefficients in the remoter parts of the asiatic continent. — There are also points of special interest, the min. near lat. 50° and 12° W., the drop of the Chicago coefficient (no doubt due to the great lakes), the „mediterranean" value of the coefficients of New Orleans and Galveston at the northern coast of the mexican gulf, and the equality of St. Pauls, in the interior of the North-American continent, and Wladiwostock at the coast of the Japan Sea.

In the preceding researches the difference in height is not taken into account, the same being in most cases very moderate and of little consequence, as shown in the special researches, part V.

29. To prevent misunderstandings the Author thinks it right to make the following remarks. In several parts of these researches stress has been laid upon the fact, that places, analogically as well as differently situated, produce coefficients of equal value. These remarks are not made in order to touch a weak point in the usual graphical representation of the phenomenon of equal amplitude of temperature, but because this relation of the coefficient *MV* to the more or less complicated physical and cultural conditions of the grounds, and to the proper geographical position, in the Authors opinion offer ample means for the numerical determination of the special factors, in which the thermo-geographical coefficient *MV* evidently may be dissolved, and, in time, for the determination of changes in the same*).

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*) Several interesting observations show, that it sometimes may be difficile enough to measure and record the true temperature due to a place. — On his march through the endless tropical primitive forests in the dark country, Mr. Henry Stanley, for inst., was exposed to a great deal of cold, the propagation of heat being arrested by the thick leafage. — On the other hand aeronauts report, that cold is experienced, when passing over wooded grounds, but heat, when over calcareous and sandy plains.

SCHEME SHOWING THE MOVEMENT OF THE COEFFICIENT *MV* IN DIFFERENT MERIDIANS.

lat. N.	*long. c. 90° W.*	*c. 53° W.*	*c. 10° W.*	*c. 30° E.*	*c. 80° E.*	*c. 133° E.*
c. 73°	. . . . .	Upernivik 8,72				
71°	. . . . .	. . . . .	Jan Mayen 4,08	. . . . .	. . . . .	Ustjansk 16,64
70°	Boothia fel. 13,16	. . . . .	. . . . .	Vardø 4,71		
69°	. . . . .	Jacobshavn 7,63				
		Egedesminde 7,22				
68°	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	Werchojansk 21,62
66°	. . . . .	. . . . .	. . . . .	. . . . .	Turuchansk 12,53	
65°	. . . . .	Sukkertoppen 6,27	Berufjord 3,54	Kem 8,19		
64°	. . . . .	Godthaab 5,27				
63°	. . . . .	. . . . .	. . . . .	Kuopia 8,57		
62°	. . . . .	. . . . .	Thorshavn 2,64	. . . . .	. . . . .	Jakutsk 19,72
61°	. . . . .	Ivigtut 5,31				
		(Julianehaab) 5,19				
60°	. . . . .	. . . . .	. . . . .	St. Petersbg. 8,61		
59°	. . . . .	. . . . .	. . . . .	Novgorod 8,54	Narym 12,49	
57°	York Fact. 14,30	. . . . .	. . . . .	. . . . .	Tomsk 11,78	
53°	. . . . .	. . . . .	. . . . .	. . . . .	Barnaul 12,30	
52°	. . . . .	(Belle Isle) 7,29	Valentia 2,63	. . . . .	Ulala 11,98	
51°	. . . . .	. . . . .	. . . . .	Tschernigow 8,68		
50°	Winnipeg 12,91	. . . . .	. . . . .	Kiew 8,54	Semipolat. 13,05	Blagowetsch. 14,51
48°	. . . . .	St. Johns, NF. 6,21	North Atl. 2,40	. . . . .	. . . . .	Chaborowka 14,41
46°	. . . . .	. . . . .	. . . . .	Odessa 8,17		
45°	St. Pauls 10,49					
43°	. . . . .	North Atl. 4,82	North Atl. 2,86	. . . . .	Wjernoje 11,21	Wladiwostock 10,49
						Askold 10,08
42°	Chicago 8,51					
41°	Council Bl. 9,86	. . . . .	. . . . .	Constantin. 5,86		
	Omaha 9,54					
40°	. . . . .	. . . . .	. . . . .	. . . . .	Margelan 9,58	
39°	. . . . .	. . . . .	Lisbon 3,50			
38°	St. Louis 8,22	North Atl. 3,54	. . . . .	Smyrna 5,88		
37°	Cairo 7,62					
35°	Memphis 7,08					
34°	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	Shimonoseki 6,64
33°	. . . . .	North Atl. 2,74	. . . . .	. . . . .	. . . . .	Nagasaki 6,72
32°	. . . . .	. . . . .	. . . . .	. . . . .	Lahore 6,82	
31°	. . . . .	. . . . .	Mogadore 3,64	Alexandria 3,66		
				Port Saïd 4,13		
30°	New Orleans 5,02	. . . . .	. . . . .	Cairo 5,35		
				Suez 5,06		
29°	Galveston 5,38	. . . . .	. . . . .	. . . . .	Delhi 5,82	

Proposed numerical climatological definitions.

30. The intimate relations between the coefficient *MV*, the geographical situation, and the distribution of the mean yearly temperature of the place, makes the function *MV* exceedingly useful and well adapted for numerical definitions in the climatology. After repeated examinations of the coefficient, the Author proposes the following classification.

Value of *MV*	Definition of Climate	Class of Climate
up to $3_{,0000}$ °C. .	tropical and extreme insular climate . .	I
from $3_{,00}$ - $4_{,0000}$ . .	extreme coast climate	II
— $4_{,00}$ - $6_{,0000}$ . .	normal coast climate	III
— $6_{,00}$ - $9_{,0000}$ . .	normal continental climate	IV
— $9_{,00}$ - $11_{,0000}$ . .	central continental climate	V
— $11_{,00}$ - $15_{,0000}$ . .	extreme continental climate	VI
beyond $15_{,0000}$ . .	polar climate	VII

It will be an easy matter, according to this plan, to draw lines encircling places of the same class of climate, and thus divide each country or region in climatological groups, in which the acting factors originate in the same sources and only differ in degrees of effect. Of course, the lines may be drawn according to any other scale, but in either case the ensemble is certain to give a more instructive and distinct prospect of the thermal amplitude and distribution of climates, than the usual and most complicated system of curves, known under the name of „Isotalantoses“.

IV.

COMPARISON OF ACTUALLY OBSERVED AND CALCULATED MEAN YEARLY AND MONTHLY TEMPERATURE OF 112 PLACES, SITUATED IN THE ATLANTIC MIDDLE-ZONES OF THE NORTHERN HEMISPHERE.

Remarks on the statistics of temperature.

31. The comparisons instituted in part II have shown the accordance of the equations of temperature and of the transformed system of isothermals for the year, but it remains still to prove the correctness of all the equations and formulæ for the analytical determination of the mean yearly and monthly temperature in reference to actual observations at places iu the Atlantic middle-zones of the northern hemisphere. The table IX has been constructed for this purpose. The table contains in 28 columns the actually observed and the calculated yearly and monthly temperature, the geographical positions and the thermo-geographical functions and coefficients for 112 places, arranged in the sections I—VIII and in the usual order from North to South.

Tab, IX.

The series of actual observations of temperature, amounting to 179, are partly taken from Doves tables, but chiefly from the Challenger Reports, and for several places completed with series from other authentic sources.

The authority and period has, as far as possible, been given for each of the series (col. 6—8).

The observed mean yearly temperature has in each case been re-calculated from the given series of monthly temperature, and given in the columns 9 and 13—16, together with the coefficients $\Sigma\ (+\ Q_m^1)$ and MV, the amplitude of the yearly movement of temperature and class of climate.

The mean yearly temperature has been calculated for each place from its geographical position and the equations and formulæ, stated in part I—II and in the Codification (part IX), and together with the component parts of the same given in the col. 9—12.

The statistically ascertained value of the coeff. MV (col. 14) has completed the formula (12) for calculating the normal monthly temperature, given in the col. 17—28; the corresponding amplitude of the yearly movement of temperature will for all series be found in col. 15.

The temperature is in Tab. IX given in degrees Centigrade, or converted into the same from Fahrenheit by means of the official International Meteorological Tables, Paris, 1890*).

32. In the calculated temperature for the year the correction for height (col. 12) has for all places been effected at the rate of $0{,}5\ ^0$C to 100 metres, the same as applied by Prof. J. Hann in the construction of his system of annual isothermals. This constant rate is, however, a source of discrepancies, particularly when the height of the place is considerable; in judging the correctness of the analytical formulæ, this moment has therefore to be taken into consideration; a few examples will explain this. At *Stensele,* for inst., (3—337 metres), in the North of Sweden, a rate of $1\ ^0$C to 100 m. gives to the place a calculated yearly temperature differing only $0{,}4\ ^0$ C from the observed, but at *Jerusalem* (36—732 metres), and *Kouka* (38—275 m.) at the lake of Tsad in the Sahara, the difference at the normal rate is but $0{,}2\ ^0$ C and $0{,}8\ ^0$ C respectively**). The table gives numerous examples of the effect of this regulation, which in special researches should be closely examined and duly recorded.

33. There are other reasons, mentioned before, which make it a difficile task to establish comparisons in respect to the calculated and observed temperature of the same place. It is in fact questionable, whether a normal mean yearly temperature really does exist, which can be said to be the absolute true annual temperature of the place — a general basis for the comparison is therefore wanted. This conclusion also applies to monthly series, only the oscillations in these from year to year are of even greater magnitude.

It is under these circumstances satisfactorily to see, that in general the calculated series of temperature range amidst the observed series.

Tables and results of the comparison of actually observed and calculated temperature.

34. The table, given on the next page, is calculated to convey a numerically well founded and concise presentation of the difference of the observed and calculated temperature. For each of the 8 sections it contains a summary of the observed and in Tab. IX recorded temperature for the year and for the months of January and July, grouped together with the corresponding calculated temperature, counted as many times as observed series for the place are tabulated. From the total the arithmetical means

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*) This standard work on meteorological units and measures has, at the request of the Meteorological Congress of Paris 1885, been prepared under the authority of the General Directors of the meteorological service at Paris (M. *E. Mascart*) and at St. Petersbourg (M. *H. Wild*), and published by Messrs. *Gauthiers-Villars et fils,* Imprimeurs-Libraires du Bureau des Longitudes etc., Paris, 1890.

**) The figure in brackets before the height refers to the number of the place in Tab. IX.

SUMMARY OF TAB. IX.

Section	Number of places	Number of series of observations	Yearly temperature				January				July				Amplitude			
			Total		Means		Total		Means		Total		Means		Total		Means	
			observed	calcul.	observed	calcul.	observed	calcul.	observed	calcul.	observed	calcul.	observed	calcul.	observed	calcul.	observed	calcul.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
I	21	47	+ 306,50	+ 318,87	+ 6,521	+ 6,784	+153,05	−194,04	− 3,26	− 4,13	+ 805,62	+ 798,11	+17,14	+16,98	969,89	992,15	20,64	21,11
II	17	29	+ 405,92	+ 397,74	+15,034	+14,731	+116,67	+100,92	+ 4,49	+ 3,88	+ 623,71	+ 617,86	+23,99	+23,76	515,75	516,94	19,84	19,87
III	11	15	− 5,11	− 2,04	− 0,341	− 0,136	−300,51	−294,46	−20,03	−19,63	+ 285,00	+ 271,18	+19,00	+18,08	575,95	565,64	38,39	37,71
IV	9	12	+ 254,80	+ 245,93	+21,233	+20,494	− 10,83	− 11,56	− 2,17	− 2,31	+ 141,56	+ 140,13	+28,31	+28,03	154,00	151,69	30,80	30,34
V	14	19	+ 122,89	+ 132,87	+ 6,468	+ 6,993	+ 19,46	+ 13,31	+ 1,02	+ 0,70	+ 231,31	+ 244,60	+12,17	+12,87	228,54	231,29	12,03	12,17
VI	17	19	+ 318,50	+ 308,27	+16,763	+16,224	+187,23	+158,69	+11,70	+ 9,92	+ 344,99	+ 329,42	+21,56	+20,59	176,83	170,73	11,05	10,67
VII	6	12	− 48,78	− 44,41	− 4,065	− 3,701	−203,82	−203,22	−16,99	−16,94	+ 97,76	+ 103,98	+ 8,15	+ 8,67	315,04	307,20	26,25	25,60
VIII	17	26	+ 453,79	+ 430,62	+17,453	+16,562	+ 73,14	+ 45,44	+ 3,85	+ 2,39	+ 461,04	+ 444,54	+24,27	+23,40	394,24	399,10	20,75	21,01
Total =	112	179	+1808,51	+1787,85	+10,218	+10,101	−271,71	−384,92	− 1,709	− 2,421	+2990,99	+2949,82	+18,811	+18,552	3330,24	3334,74	20,945	20,973
mean difference . .			—		− 0,117° C		—		− 0,712° C		—		− 0,259° C		—		+ 0,028° C	

Remarks.

In the Northern Sections I—III—V and VII all series of observations (93) are included in the figures, given in the columns 3—18.
In the Southern Sections II—IV—VI and VIII the following are excluded of the total number of series (86):

in Section II, in all columns, 2 series for Bukarest (27), abnormal, and in the colums 7—18, one series for Kouka (38), tropical;
in Section IV, in the columns 7—18, 7 series for Delhi, Benares, Calcutta and Bombay (55—58), tropical;
in Section VI, in the columns 7—18, 3 series for the North Atlantic and Las Palmas (87—89), tropical;
in Section VIII, in the columns 7—18, 7 series for Havanah, the North Atlantic and St. Croix (110—112), tropical.

Consequently the total number of series actually taken into account makes

	in the col. 3—6,	7—18
for Section I	47	47
„ — II	27	26
„ — III	15	15
„ — IV	12	5
„ — V	19	19
„ — VI	19	16
„ — VII	12	12
„ — VIII	26	19
	= 177	= 159

are taken, and both given in the table. The amplitude of temperature is dealt with in the same manner.

The months of January and July are selected as generally giving the largest and smallest amount of variation.

Some few places are excluded as specified in the remarks, accompanying the table.

The relation of the means of calculated to the means of observed temperature in this table leaves, in respect to the congruity of both series, very little to desire, and this holds good, whether the sections are considered separately, or the total effect of the formulæ for the whole area is noticed. The differences are in all quarters but small, and only for the month of January in the sections VI and VIII they assume a value exceeding 1 °C (1,78 and 1,46 respectively), but even the mean difference for this month (0,71) may be said to be of little consequence, whilst, in fact, the mean difference for the year (0,12), for July (0,26), and in respect to the amplitude of temperature (0,03), comes next to null.

The general impression of correctness in the working of the equations and formulæ is not in any sensible degree weakened by a survey of the special series of observations, presented in Tab. IX, and the above remarks find, too, their full support in the general statistics. The examination in detail must necessarily be left to institutions and persons specially interested in the matter, but two series of observed mean temperature of months and years may here be noted, as examples of the amplitude of oscillations in temperature, occasionally recorded; one series relates to *Paris* and the long period of 120 years, given by M. E. Renou, and the other to *Copenhagen* and a short period of 10 years, taken from the publications of the Met. Institute of Copenhagen.

	PARIS record of temp. during the period 1761—1880.			COPENHAGEN record of temp. during the period 1885—1894.		
	extreme mean temp.		total difference	extreme mean temp.		total difference
January	−6,3	+ 7,8	14,1 °C	−6,3	+2,3	8,6 °C
February	−0,9	+ 8,5	9,4	−2,8	+1,8	4,6
March	+1,1	+10,3	9,2	−3,1	+4,1	7,2
April	5,7	15,1	9,4	+2,3	+7,6	5,3
May	10,6	17,9	7,3	9,7	13,0	3,3
June	13,8	21,2	7,4	13,3	18,6	5,3
July	15,5	22,6	7,1	14,7	17,7	3,0
August	15,5	22,7	7,2	14,2	16,7	2,5
September	12,9	19,4	6,5	11,1	14,0	2,9
October	7,3	14,7	7,4	6,9	10,6	3,7
November	2,3	10,5	8,2	3,3	6,8	3,5
December	−7,6	+ 8,6	16,2	−1,5	+3,3	4,8
the year	+8,8	+12,7	3,9	+6,4	+8,4	2,0

The latitude and the geographical situation of Paris and Copenhagen makes it probable, that the above differences are moderate, and that in more northerly and

continentally situated places the differences in extended periods will be found to be of still greater magnitude. In view of these variations, and once more pointing to the summary of Tab. IX as well as to the details in the table itself, it seems, that all researches and reflections concur in the conclusion, that the calculated series of temperature in all respects represent the series, obtained as means of many years of actual observation.

There are still other moments to be taken into account in support of this conclusion.

Comparison of the dynamo-cosmical factors to oscillations in the observed monthly temperature.

35. In search of analytically constructed standard series of temperature it is namely of importance, not only closely to watch the stability of the coefficients and terms, of which the equations and formulæ are composed, but also the effect of variations in the same. — In respect to the analytical determination of the yearly temperature, the researches in part II and the extensive application of the equations, recorded in Tab. IX and discussed in the preceding paragraphs, leave little doubt as to the correctness of the method and means employed, particularly not, when the modul of correction for height has been revised. The stability of the terms, of which the function $\Sigma(+ Q_m)$ is composed, has been amply proved in part III, and it remains therefore now to examinate the working of the coefficients Q_m and MV in the formulæ for the months.

If, for this purpose and to begin with, the fluctuations in the statistical value of $\Sigma(+ Q_m^1)$ and MV (Tab. IX, col. 13 and 14) are compared, it will be found, that in most of the places, for which several series have been produced, the variation of MV is comparatively of much less amplitude, than that of $\Sigma(+ Q_m^1)$; this proves once more the superiority of an annual function *(MV)* over one, determined by special months (Q_m^1 and $\Sigma(+ Q_m^1)$). It is, however, not the statistical, but the theoretical value of the terms Q_m, which enters the formulæ for the months, and it is therefore the relation between both, which requires to be investigated. If then in the formula (12) all variations are applied to the term Q_m, and all other factors considered as constant, then the effect of variations of Q_m may be determined as follows.

The statistical value of Q_m^1 may be expressed in terms of the theoretical value of Q_m; thus

$$Q_m^1 = Q_m + \delta(Q_m) = Q_m\,(1 + \delta),$$

in which δ assumes any positive or negative value; we have then from (12)

$$\pm\, n^\circ = MV\,\frac{6\,Q_m\,(1 \pm \delta)}{3,_{8874}} - MV\,\frac{6\,Q_m}{3,_{8874}}$$

or

$$\pm\, n^\circ = \delta\,(1,_{5434}\,Q_m)\,MV$$

and

$$\delta = \pm\,\frac{n^\circ}{1,_{5434}\,Q_m\,.\,MV}$$

If now n^0 be taken equal to $\pm$ 1 °C and $MV = 5{,}000$, then the corresponding value of δ, expressed in percentage of the theoretical coefficient Q_m, will be found for the different months to be as follows:

January	$\pm 12{,}1$ %	July	$\pm 13{,}0$ %
February	$14{,}8$ %	August	$14{,}0$ %
March	$21{,}7$ %	September	$21{,}7$ %
April	$178{,}6$ %	October	$104{,}5$ %
May	$29{,}2$ %	November	$31{,}9$ %
June	$16{,}2$ %	December	$15{,}0$ %

A difference of $\pm$ 2° requires twice the above percentage, $MV = 10^0{,}000$ half of the same and so on, in direct or reverse proportion respectively.

According to the above analysis, and even in case of difference in the numerical term $\Sigma(+ Q_m^1)$, a considerable variation in Q_m will be required to produce a variation of only 1° in the monthly temperature; the term $MV \frac{6\ Q_m}{\Sigma(+ Q_m)}$ may therefore be considered as a very satisfactory combination of a normal function, in possession of the valuable quality of compensating for statistical uncertainties in the separate factors.

The above arguments may now be direct applied to the Renou and the calculated series of Paris (Tab. IX, 22), only the constant difference of $M = 0{,}503$ °C has to be eliminated in the calculated series, in order to bring the comparison on equal terms. MV is in both series $= 5{,}2483$ and $\Sigma(+ Q_m^1)$ in series Renou $= 3{,}8804$. We have then:

	series Renou mean temp.	calcul. series mean temp.	difference calcul. – Renou Δ	series Renou Q_m^1	theoretical Q_m	δ
January	$+2{,}20$ °C	$+1{,}965$ °C	$-0{,}235$ °C	$-1{,}0394$	$-1{,}0703$	$2{,}71$ %
February	$4{,}21$	$3{,}528$	$-0{,}682$	$-0{,}7917$	$-0{,}8773$	$9{,}60$
March	$6{,}33$	$5{,}796$	$-0{,}534$	$-0{,}5305$	$-0{,}5973$	$11{,}04$
April	$10{,}12$	$10{,}059$	$-0{,}061$	$-0{,}0635$	$-0{,}0711$	$10{,}59$
May	$13{,}93$	$14{,}228$	$+0{,}298$	$+0{,}4060$	$+0{,}4436$	$8{,}29$
June	$17{,}10$	$17{,}129$	$+0{,}029$	$+0{,}7967$	$+0{,}8018$	$0{,}45$
July	$18{,}75$	$18{,}735$	$-0{,}015$	$+1{,}0000$	$+1{,}0000$	$0{,}19$
August	$18{,}70$	$18{,}102$	$-0{,}598$	$+0{,}9938$	$+0{,}9218$	$8{,}01$
September	$15{,}74$	$15{,}465$	$-0{,}275$	$+0{,}6291$	$+0{,}5963$	$5{,}69$
October	$11{,}08$	$11{,}638$	$+0{,}558$	$+0{,}0548$	$+0{,}1239$	$55{,}59$
November	$6{,}27$	$7{,}348$	$+1{,}078$	$-0{,}5379$	$-0{,}4058$	$32{,}80$
December	$3{,}19$	$3{,}623$	$+0{,}433$	$-0{,}9174$	$-0{,}8656$	$6{,}18$
the year	$10{,}635$	$10{,}635$	0	$\pm 3{,}8804$	$\pm 3{,}8874$	—

From the above analysis of the Renous series for Paris, representing the revised means of 120 years of observation, and comparing the same to the calculated series, the

difference Δ in the table must be said to be but a very trifling one, and very far from any of the limits of temperature observed during the period. The difference of the factors Q_m^1 and Q_m are also rather ineffective, as will be seen from the coefficient δ, which but in one month, November*), reaches a value corresponding to a difference of temperature of $\pm$ 1° C. — All the differences are spread over the year in no apparent order.

The *Francfort* experiment**) should here be mentioned in connection with the Renou series. — The Francfort series (21, Tab. IX) represent an experiment, which is instructive in respect to the attempts made by Greis-Mermann to fix the normal daily mean temperature on the basis of 20 years of observation, the normal mean temperature of each day being made equal to the arithmetical means of the 15 preceding and succeeding days (total 31 days) of the 20 years series. The results of this combination are given in Tab. IX and in the following table.

	Series of 20 years, mean temp.	Series Greis-Mermann, mean temp.	Calculated Series, mean temp.	Differences Δ (3−1)	Differences Δ_1 (3−2)	Series of 20 years, Q_m^1	Series Greis-Mermann, Q_m^1	Theoretical Series, Q_m
	1	2	3	4	5			
January . .	−0,411 °C	−0,258 °C	−0,375 °C	+ 0,036 °C	−0,117 °C	−1,0513	−1,0415	−1,0703
February . .	+1,147	+1,170	+1,445	+0,297	+0,275	−0,8868	−0,8895	−0,8773
March . . .	4,028	4,274	4,085	+0,057	−0,189	−0,5828	−0,5602	−0,5973
April	9,379	9,292	9,048	−0,332	−0,244	−0,0184	−0,0280	−0,0711
May	14,214	14,141	13,901	−0,313	−0,240	+0,4917	+0,4863	+0,4436
June	17,946	17,838	17,279	−0,667	−0,558	0,8854	0,8784	0,8018
July	19,032	18,984	19,149	+0,117	+0,165	1,0000	1,0000	1,0000
August	18,815	18,480	18,411	−0,403	−0,069	0,9770	0,9465	0,9218
September . .	14,900	15,033	15,342	+0,442	+0,308	0,5641	0,5810	0,5963
October . .	10,085	9,948	10,887	+0,802	+0,939	+0,0560	+0,0415	+0,1239
November*).	4,729	4,833	5,892	+1,162	+1,054	−0,5090	−0,5005	−0,4058
December . .	0,778	0,932	1,555	+0,777	+0,623	−0,9258	−0,9148	−0,8656
the year . .	9,554	9,556	9,718	+0,165	+0,162	±3,9742	±3,9328	±3,8874

*) In the course of these researches several irregularities have been met with in regard to this month. Perhaps part of these are due to the circumstance, that in the meteorological year, when commencing with either December or January, the continuity of the winter-months, or analytically the negative months, is broken, and the probable compensation in the meteorological factors of the consecutive months thus prevented. A meteorological year composed of the months November to October would be much more in harmony with the succession of the seasons.

**) This experiment is fully described in Prof. Joh. Müllers handbook of cosmical physic, 1883, where also the two series of daily temp. will be found, from which the monthly means for the present use have been derived. The cause of the slight anomaly in the mean yearly temp. has not been traced.

The table shows the mean temperature, as well as the functions Q_m^1 in the Greis-Mermanns series to be materially the same as those in the original one, and on the whole, that this attempt to replace actual series of observation by statistical experiments has not been successful.

One observation in reference to the Renous as well as to the Greis-Mermanns series should be noticed; the signs of Q_m^1 in both series correspond namely exactly to those in the theoretical series, and this is the case also in the months of transit (April and October), in which the limiting values approach the zero; this result is of importance as confirming the term of „retardation“, introduced in the formula (12).

Specimen of a complete series of analytical operations.

36. Special researches relating to the thermo-geographical component (Tab. IX, col. 11) are transferred to part V, and now postponing further investigations in detail of Tab. IX, the Author re-produces on the next page, in addition to this table, a specimen of the operations and arrangements, found useful in practical work for the calculations required to complete the series of temperature, (New York, Tab. IX, 100).

The position of calculated series of temperature as compared to observed series.

37. In the preceding researches it has repeatedly been proved, that the analytical series of temperature take position amidst series obtained as means of observations in periods of long duration. The true normal yearly movement of temperature over the northern temperate and polar zone is consequently, according to the formula employed, directed almost exclusivèly by dynamo-cosmical and terrestrial factors, leaving but a small margin for meteorological elements. If therefore in the long run the resultant of meteorological perturbations becomes $= 0$, it may be concluded, that the formula (12) is exact, but otherwise the same will require some local corrections.

NEW YORK $\varphi = 40^0\,43'$ $\lambda = 74^0\,0'$ W. $H = 50$ metres.

$log\ cos\ \lambda = 0,_{4403381-1}$
$log\ cos\ \varphi = 0,_{8796375-1}$
$= 0,_{3199756-1}$

$2\ log\ cos\ \lambda = 0,_{8806762-2}$
$log\ cos\ \varphi = 0,_{8796375-1}$
$= 0,_{7603137-2}$

$log\ cos\ \lambda = 0,_{4403381-1}$
$2\ log\ cos\ \varphi = 0,_{7592750-1}$
$= 0,_{1996131-1}$

$2\ log\ cos\ \lambda = 0,_{8806762-2}$
$2\ log\ cos\ \varphi = 0,_{7592750-1}$
$= 0,_{6399512-2}$

$+\ log\ a = 0,_{7106166-1}$	$+\ log\ b = 0,_{7961189}$	$+\ log\ const = 0,_{2832289}$	$A\ cos\ \varphi = 0,_{10730}$
$0,_{3199756-1}$	$0,_{7603137-2}$	$log\ cos\ \varphi = 0,_{8796375-1}$	$0,_{36011}$
$0,_{0305922-1}$	$0,_{5564326-1}$	$0,_{1628664}$	$1,_{45501}$
$= +\ 0,_{10730}$	$= +\ 0,_{36011}$	$= +\ 1,_{45501}$	$= +\ 1,_{92242}$
$+\ log\ a_1 = 0,_{8260294-1}$	$-\ log\ b_1 = 0,_{7660874}$	$-log\ const_1 = 0,_{6352525-1}$	$B\ cos\ \varphi^2 = 0,_{25471}$
$0,_{1996131-1}$	$0,_{6399512-2}$	$2\ log\ cos\ \varphi = 0,_{7592750-1}$	$0,_{24804}$
$0,_{0256425-1}$	$0,_{4060386-1}$	$0,_{3945275-1}$	$-\ 0,_{50275}$
$= +\ 0,_{10608}$	$= -\ 0,_{25471}$	$= -0,_{24804}$	$+\ 0,_{10608}$
			$= -\ 0,_{39667}$
$-\ log\ a_{11} = 0,_{9347155-1}$	$-\ log\ b_{11} = 0,_{0392144}$		$C = 0,_{23717}$
$0,_{4403381-1}$	$0,_{8806762-2}$		$0,_{08316}$
$0,_{3750536-1}$	$0,_{9198906-2}$		$0,_{48766}$
$= -\ 0,_{23717}$	$= -\ 0,_{08316}$	$-\ const_{11} = -0,_{48766}$	$= -\ 0,_{80799}$

$0,_{39667}$
$0,_{80799}$
$-\ 1,_{20466}$
$+\ 1,_{92242}$
$cos\ \varphi_1 = +\ 0,_{71776}$ $log = 0,_{8559793-1}$

$log\ 31,_{7544} =$	$1,_{5018039}$	$log\ 18,_{6395} = 1,_{2704343}$	
	$0,_{8559793-1}$	$0,_{7119586-1}$	
	$1,_{3577832}$	$0,_{9823929}$	
	$22,_{7920}$	$9,_{6027}$	
	$9,_{6027}$	$1,_{5018039}$	$1,_{2704313}$
	$+\ 32,_{3947}$	$0,_{8796375-1}$	$0,_{7592750-1}$
	$-\ 21,_{7620}$	$1,_{3814414}$	$1,_{0297093}$
$T\varphi, \lambda$	$+\ 10,_{6327}$	$24,_{0681}$	$10,_{7080}$
Correction for 50 m.	$-\ 0,_{2500}$	$10,_{7080}$	
New York, the year	$= +\ 10,_{3827}\ ^0C$	$+\ 34,_{7761}$	
		$-\ 21,_{7620}$	
		$T\varphi = +\ 13,_{0141}\ ^0C$	

$T\varphi, \lambda$ . . $+\ 10,_{6327}\ ^0C$
$T\varphi$ . . . . $+\ 13,_{0141}$
$t\varphi, \lambda$ . . $-\ 2,_{3814}\ ^0C$

NEW YORK, the year $= +\ 10,_{3827}\ ^0C$.

$MV = 8,_{0500}\ ^0C\ log = 0,_{9057959}$.

January . . $-0,_{2179777}$
$0,_{9057959} = -1,_{1237736} = -13,_{2976} + 10,_{3827} = -\ 2,_{9149}\ ^0C$

February . . $-0,_{1316446}$
$0,_{9057959} = -1,_{0374405} = -10,_{9003} + 10,_{3827} = -\ 0,_{5176}$

March . . . . $-0,_{9647108-1}$
$0,_{9057959} = -0,_{8705067} = -\ 7,_{4218} + 10,_{3827} = +\ 2,_{9609}$

April . . . . $-0,_{0404272-1}$
$0,_{9057959} = -0,_{9462231-1} = -\ 0,_{8835} + 10,_{3827} = +\ 9,_{4992}$

May . . . . $+0,_{8354489-1}$
$0,_{9057959} = +0,_{7412448} = +\ 5,_{5112} + 10,_{3827} = +15,_{8939}$

June . . . . $+0,_{0925463}$
$0,_{9057959} = +0,_{9983422} = +\ 9,_{9619} + 10,_{3827} = +20,_{3446}$

July . . . . $+0,_{1884965}$
$0,_{9057959} = +1,_{0942924} = +12,_{4249} + 10,_{3827} = +22,_{8076}$

August . . . . $+0,_{1531379}$
$0,_{9057959} = +\ 1,_{0589338} = +11,_{4534} + 10,_{3827} = +21,_{8361}$

September . . $+0,_{9639613-1}$
$0,_{9057959} = +0,_{8697572} = +\ 7,_{4090} + 10,_{3827} = +17,_{7917}$

October . . $+0,_{2816379-1}$
$0,_{9057959} = +0,_{1874338} = +\ 1,_{5397} + 10,_{3827} = +11,_{9224}$

November . . $-0,_{7967764-1}$
$0,_{9057959} = -0,_{7025723} = -\ 5,_{0416} + 10,_{3827} = +\ 5,_{3411}$

December . . $-0,_{1258188}$
$0,_{9057959} = -1,_{0316147} = -10,_{7551} + 10,_{3827} = -\ 0,_{3724}$

$M = +10,_{3827}\ ^0C$

V.

SPECIAL RESEARCHES AND REPRESENTATIONS OF THE THERMO-GEOGRAPHICAL FUNCTIONS.

Remarks on the principle of distinguishing in thermal equations between factors of cosmical and geographical nature.

38. The plan, in the construction of the equations of temperature to distinguish between factors of cosmical or general nature and geographical or local factors, has in these studies been occasionally illustrated by comparing the temperature of certain places or regions to more distinctive properties, observed in the configuration of the earths surface. But the interesting and instructive analytical relations of temperature to the physical geography are not limited to the leading features in the construction of the surface or to dynamic powers of recognized importance, but include also the composition of the territory, surrounding the place concerned. Extensive investigations at various, analogically and differently situated geographical localities are needed to work out the full capacity in this sense of „the annual thermo-geographical component $(t\varphi, \lambda)$“ and „the thermo-geographical coefficient (MV)“, but from what has already been stated, it seems, that a fair prospect is opened through these numerical terms further to decompose the formulæ in respect to details in the physical and dynamic constitution of the earths surface*). The interest in these special studies is perhaps particularly attached to the coefficient MV, the only term in the equations, which has not yet been analytically determined**)

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*) The determination of „the meteorological series“, and „displacement of the Months“ in respect to the thermal order of the same, referred to and dealt with in part VI and in the Codification, may no doubt offer another class of suitable objects for minute investigations.

**) The value of MV (col. 14), as given in the calculated series Tab. IX, is the approximate means of MV in the observed series of the place, regard being taken to length of period and other moments, determining the weight of the observations. In the table adjoining § 34 the amplitude, for its constant relation to MV, also represents this coefficient.

The following additional researches, together with maps and graphical representations, specially constructed for the purpose, will assist in the further study of thermo-geographical relations. The plans are specified in the Appendices as follows:

referring to *the annual thermo-geographical component* ($t\varphi$, λ).

Plan I, map showing the systematical distribution of the geographical component of the annual temperature over the northern Hemisphere, and — Plan I.

referring to *the thermo-geographical coefficient MV*.

Plan II and III, graphical representation of the movement of the coefficient *MV* in different northern parallels, and in heights in the Alpine regions. — Plan II and III

39. In Tab. IX, col. 10—12, the decomposition of the calculated mean yearly temperature in its three defined components has been effected, and thus the normal temperature due to the latitude, the decrease due to height, and the annual thermo-geographical component have been specified for each place; in this manner the means are provided for a comparison of the last named component to the data, given for the regularly arranged positions in the tables II—IV.

The map of the northern hemisphere, Plan I, with the numerical representation of that component of the annual temperature, which is due to terrestrial forces, will perhaps be specially welcome to persons, interested in the study of physical geography and the intimate connection of the physical and dynamic factors, which set their mark in the temperature, as shown by the figures, inscribed on the map*).

40. A comparative examination of Tab. IX, the tables II—IV and the Plan I in respect to the annual thermo-geographical component will no doubt offer many points in favor of the numerical representation of the distribution of temperature, and especially in respect to the qualification of the same for interpolating the geographical component ($t\varphi$, λ). — Numerical representation of the annual thermo-geographical component.

Not only the circumstance, that the normal latitudinal temperature has been eliminated, renders the interpolation of the terrestrial factor more correct, but it would seem, that the even movement in the annual thermo-geographical component makes this term particularly well adapted for minute researches and interpolations of temperature. The evenness in the movement of this element, conspicuous in

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*) The Author may be allowed at this place to state, that readers in a great measure are indebted to Lieut. Col. *Axel Staggemeier* of Copenhagen for this map, the original plate of which he placed at disposal for the special adaptation, shown in the appendix to this work. — The maps of Staggemeiers physical atlas are noted for exactness and exquisite execution, and have by several scientific authorities, naval institutes and others been recognized as admirably serviceable for the representation of geo-physical, chiefly meteorological observations, and for many other purposes.

Plan I, is to a certain degree due to the „level“ surface, but also a consequence of the successive rise and decline in the effect of continually acting thermo-geographical factors*). This quality of the geographical component gives to the same a certain power of control, because thermometrical observations at places, analogically situated within moderate distances from each other, cannot under normal conditions produce considerable variations in the value of this factor**). The analysis of the observations at *Bukharest* (Tab. IX, 27) illustrates these remarks.

The observed and the calculated series of temperature give namely for this place the following data:

Authority	mean yearly temperature	normal temp. at lat. 44° 25′	thermo-geogr. component	correction for height
Dove (2 years)	+ 7,9692 °C	+10,4287 °C	—1,9945 °C	—0,4650 °C
Chall. Rep. (15 years)	+10,5425	+10,4287	+0,5788	—0,4650
Calcul.	+12,2936	+10,4287	+2,3299	—0,4650

Now, at Bukharest a negative value of the thermo-geographical component is out of question, and even a value = + 0,58 is too small for the eastern Mediterranean and Black Sea countries, whilst + 2,33 in the calculated series in every respect is in accordance with that determined for other not very distant places, for inst. Sebastopol + 1,92 and Constantinople + 2,22. These examinations indicate then, that in this case the calculated series most probably is nearer the true mean yearly temperature of Bukharest than the observed series, and as a consequence of these anomalies the Bukharest series have been excluded from the summary of Tab. IX, § 34***).

The following examples illustrate the use of Tab. IV, or the numerical representation of the thermo-geographical component, as basis for the interpolation of the mean yearly temperature. We find

	NEW YORK $\varphi = 40°43'$ $\lambda = 74°0'$ W. $H = 50_m$	BERLIN $\varphi = 52°30'$ $\lambda = 13°23'$ E. $H = 41_m$
normal latitudinal temp., calcul.	+13,014 °C	+4,476 °C
thermo-geogr. component, interpol. . . .	— 2,384	+4,483
mean yearly temp. at sea-level	+10,630	+8,959
correction for height	— 0,250	—0,205
interpolated mean yearly temperature . .	+10,380	+8,754
calculated — — — . .	+10,383	+8,780

*) Remarks in the explanatory introduction to „Atlas des Atlantischen Oceans“, Art. 4. Deutsche Seewarte, Hamburg, 1882.

**) The effect of abrupt and extraordinary local formations is of course not included in general researches and must be reserved for special studies.

***) The Bukharest case is no doubt one of peculiar interest and should be fully investigated.

The data for interpolation of the annual thermo-geographical component are taken from Tab. IV as follows;

	NEW YORK				BERLIN		
	90°	80°	70° W.		10°	20°	30° E.
45° ..	−3,044	−3,932	−3,525	55° ..	+6,032	+4,574	+3,240
40° ..	−2,191	−2,450	−1,795	50° ..	+4,111	+2,923	+1,791
35° ..	−1,487	−1,174	−0,469	45° ..	+3,007	+2,636	+2,106

Judging from the above results it seems, that intervals of 10° in longitude (or of 5° on both sides of Greenwich meridian) and 5° in latitude are sufficient for obtaining good approximations, provided 2 or 3 decimals be employed. — Another mode of interpolation may be had by measurements on a graphical representation of the component; the scale need not be very extensive in order to allow such measurements for intermediate positions to be taken with quite a satisfactory correctness.

Remarks on the graphical representation of the annual thermo-geographical component.

41. The geographical position of the null-points and points of inflexion in the figures, representing the thermo-geographical component, is of principal interest, particularly the null-points. The position of these is easily interpolated with sufficient accuracy by means of the tables II—IV and the Plan I; from the latter it will at once be seen, that no null-points are found on the Northern Hemisphere between about 10° W. and 50° E., that is to say, the whole of Europe and western Asia is favoured with a permanent supply of additional heat, whilst the annual temperature of large parts of central and eastern Asia and America is below the zero, or below the normal temperature of the parallels.

The numericals, given on Plan I, are easily transformed into a graphical representation of the geo-physical function $t_{\varphi,\,\lambda}$; the same would illustrate the difference of types of the curves North and South of the parallel 50°. The curve of 50° itself is especially remarkable for the rapidly increasing and decreasing influence of the Atlantic Ocean and the Gulf stream, and the 40° curve for its parallelism with the axis of the Mediterranean.

It should be observed, that the continuation of the numerical representation, Plan I, beyond the meridians 90° W. and E., and the junction of the calculated (Atlantic) and the observed (Pacific) parts, offer no irregularities, calling for special remarks or explanations; this is an evidence, although now superfluous, of the congruency of the analytical and the interpolated part on the map, showing the movement of the thermo-geographical component over the Northern Hemisphere.

On the annual thermo-geographical components of the Atlantic Ocean.

42. The numerical determination of the thermo-geographical component partakes in the degree of precision, which in general is assigned to the annual functions; in regard to Oceans it should, however, be observed, that a source of incorrectness is avoided, because no correction for height is required.

These remarks refer particularly to the Atlantic Ocean, in respect to which an exact determination of this important geographical function certainly is of the highest

interest for the invaluable contribution to our knowledge of the distribution of heat over the Northern Hemisphere, which would accrue from the combination of analytical investigations and the numerous works and researches on the Atlantic Ocean and the Gulf stream, considered from the thermal point of view. — This problem is, however, too far-reaching and important to be exposed to compendious or sporadic researches only, but as a preliminary introduction to the subject, and as an addition to preceding remarks and to the numericals given in tables and plans, the following special comparison of analytical results to a limited number of actual observations on shore and at sea, concerning the North-Atlantic Ocean, may here find a place.

The geographical scheme, presented on the pages 76 and 77, shows the calculated and observed mean yearly temperature and the thermo-geographical component of 25 places on shores and islands of the Atlantic Ocean and of 19 places at sea, chiefly near the shore and in the meridian 47° 30′ W., forming a continuation of the West-Coast of Greenland. — The calculated temperature is given on the left side and the observed on the right side of the mark of the place, the upper figures indicating the mean yearly temperature and the lower the thermo-geographical component. The 25 shore-stations represent 37 series of actual observations, all given on the plan together with number of years of the period in brackets. The places at sea are marked N. A., and are all taken from the Challenger Reports ($5^2/_3$ years). — The positions and figures in this scheme are all taken from Tab. IX.

Now arises the question of an eventual difference in the relation of the calculated temperature to the observations on shore and to those at sea. The following results of comparisons will help to answer that query. We find

	observations	calculated
Total of 37 series on shore	$+342_{,5673}$ °C	$+328_{,1286}$ °C
means	$9_{,259}$	$8_{,868}$
or	$100_{,00}$	$95_{,78}$
Total of 19 series at sea	$+290_{,0215}$ °C	$+281_{,0817}$ °C
means	$15_{,264}$	$14_{,790}$
or	$100_{,00}$	$96_{,90}$

to which may be compared

Total of 76 series in the western quadrants . .	$+846_{,40}$ °C	$+827_{,35}$ °C
means	$11_{,137}$	$10_{,886}$
or	$100_{,00}$	$97_{,75}$

From these relations it may be concluded, that the observations at sea take a similar or even sligthly improved position towards the analytical series as those found by regular measurements on shore, a result which in a satisfactory manner completes the conclusion in § 22 in respect to the Challenger records of temperature over the Atlantic Ocean.

Special inquiries, extending to each of the 44 places marked on the plan, confirm the above conclusion. It will namely be found, that the difference between observed

and calculated temperature is in no place extraordinary great, whilst places are found, on shore as well as at sea, showing the best possible agreement of both series. Of such places, noted on the scheme, may be named

Stations on shore	calcul. temp.	obs. temp.
Godthaab (West-Greenland)	— 2,49 °C	— 2,90 °C
		— 1,82
		— 1,88
Ivigtut (West-Greenland)	+ 0,75	+ 0,84
		+ 1,01
Stykkisholm (Iceland)	+ 2,82	+ 2,85
		+ 2,84
New York	+10,38	+10,85
		+10,78
Cape Hatteras	+15,65	+16,21
Christiansted (St. Croix)	+26,53	+27,19

Stations on shore	calcul. temp.	obs. temp.
Thorshavn (the Farøe)	+ 6,56 °C	+ 7,56 °C
		+ 6,44
Stornoway	+ 8,64	+ 7,75
Valentia	+11,67	+10,69
Brest	+12,30	+11,71
Lisbon	+15,34	+16,33
		+15,49
St. Michael (the Azores)	+16,30	+16,90
Las Palmas (the Canaries)	+20,18	+20,86

Stations at sea		calcul. temp.	obs. temp.
North Atlantic	long. 12° 30′, lat. 57° 30′	+ 9,00 °C	+ 9,03 °C
	lat. 52° 30′	+11,49	+11,71
	lat. 47° 30′	+13,35	+14,01
	long. 47° 30′, lat. 42° 30′	+13,87	+12,90
	lat. 37° 30′	+17,40	+18,03
	long. 72° 30′, lat. 37° 30′	+13,84	+14,43
	lat. 22° 30′	+24,98	+25,73
	long. 77° 30′, lat. 32° 30′	+17,83	+18,28

That the calculated and observed temperature for about half the part of a limited number of places do agree within a minimum of difference, in several cases even exactly, and that these places are spread all over the Ocean, are no doubt facts, which considerably raise the confidence to the calculated temperature in rapport to the North-Atlantic Ocean.

This conclusion applies direct to the thermo-geographical component, given in the tables, the Codification and on Plan I, but at present the further use of these data as a basis for analytical researches concerning the North Atlantic must, for the reasons stated, be reserved for special studies. From the above observations it may, however, already now be concluded, that the annual thermo-geographical component, representing the superficial contribution to the annual temperature, is in a very satisfactory accordance with the North-Atlantic system of currents, and particularly with the general track of the Gulf stream, the branches of the same included.

The complete special studies on the distribution of temperature over the North-Atlantic Ocean do also require researches to be made in respect to such phenomena, which, according to special observations or hypotheses, probably and either temporary

or permanently may cause serious disturbances in the normal process. In view of the importance of the subject the Author has commenced preliminary studies, which at least give an acceptable and natural explanation of certain oscillations in temperature, some times ascribed to changes in cosmical powers.

Numerical representation of the thermo-geographical coefficient *MV*.

43. The physical or thermo-geographical coefficient *MV*, the numerical expression for the resultant of the terrestrial factors acting permanently upon the yearly movement of temperature, thus increasing or modifying the „cosmical" amplitude of the same, has been fully dealt with in the preceding parts, as far as regards the general movement of the factors, and the position it occupies in the present system of formulæ for the analytical determination of the normal mean monthly temperature of a place. It has also been shown, particularly in Tab. IX, that this annual function varies very little in different periods for the same place, an observation, which considerably raises the trustworthiness of this factor. — It is clear, that, based on further investigations and detailed statistical materials, tables and plans may be constructed, showing the regular distribution of the thermo-geographical coefficient *MV*, on the same scheme, as that adopted in respect to the numerical representation of the annual thermo-geographical component. — The plans II and III, giving details of the distribution of the physical coefficient, may be considered as preliminary researches in support of this plan, which again is brought under notice in part VIII of the present studies.

Relation of the thermo-geographical coeff. *MV* to the Atlantic and Pacific Ocean and the continents of the northern hemisphere.

44. In part III the attention has already been directed to the conspicuous regularity in the movement of the coeff. *MV* in several parallels and meridians, traversing North-America and Europe—Asia. On plan II this most interesting point has been in detail represented in the parallel of 50° lat. for about 270 degrees of longitude, from the West-coast of North-America to the East-coast of Europe—Asia, and on plan III this scheme has been extended to several sections of Europe—Asia, North-America and of the Scandinavian Peninsula. The curves represent in each case the movement of the coefficient *MV* along the given parallel, and on the plans all the places are enumerated and the geographical positions and corresponding values of *MV* given.

Considering now the section of 50° lat., this parallel is selected for the often specified characteristic qualities of the same, which probably make this curve a standard or normal representation of the general marche of the coefficient *MV*.

From plan II it will then be seen, that in North-America, but more especially in Europe—Asia, the progress of the coefficient *MV* from Ocean to Ocean is determined by certain points of inflexion, analogically situated in both groups, and that between these points and the starting points at the shore the coefficient moves at a simple ratio in proportion to the longitude of the place or to the distance from the ocean.

With the exception of the Atlantic part, the curve 50° lat. is consequently composed of straight lines, the fundamental points of which evidently are fixed by the

influence from the Atlantic and the Pacific, the continental stretch forming the uniting part, from the central positions in Asia as well as in North-America sloping towards the Oceans.

Now, the details of the investigations, given on the plan, show, that the following relations, as measured by the thermo-geographical coefficient *MV*, exist between the Atlantic, the Continental and the Pacific gradients or sphere of influence in the two continents.

	from	to	total range	corresponding *MV*	Mean increase (+) or decrease (−) of *MV* in proportion to 1° long.
Atlantic gradienls					
North-America ..	64° 20′ —	91° 40′ ..	27° 20′ ..	$8,_{22}$ °C — $12,_{78}$ °C ..	+ $0,_{1668}$ °C
Europe—Asia ..	0° 22′ —	52° 59′ ..	52° 37′ ..	$4,_{00}$ — $12,_{23}$ ..	+ $0._{1568}$
Continental gradients					
North-America ..	91° 40′ —	103° 42′ ..	12° 2′ ..	$12,_{78}$ — $12,_{51}$ ..	— $0,_{0225}$
Europe—Asia .	52° 59′ —	127° 38′ ..	74° 39′ ..	$12,_{23}$ — $14,_{51}$ ..	+ $0,_{0305}$
Pacific gradients					
North-America ..	103° 42′ —	121° 46′ ..	18° 4′ ..	$12,_{51}$ — $8,_{14}$ ..	— $0,_{2420}$
Europe—Asia ..	127° 38′ —	142° 7′ ..	14° 29′ ..	$14,_{51}$ — $10,_{11}$ ..	— $0,_{3039}$

The above figures prove, that irrespective of the extreme difference in magnitude of the Western and Eastern Continents, the numerical ratio of progress of the factor *MV*, determining the yearly movement of temperature or the continentality of the climate, are almost identical in both continents and in a zone, which no doubt may be calculated to reach several degrees of latitude North and South of the parallel of 50° N.

The figures appearing in the diagrams and notes Pl. III, representing sections in other parallels, confirm the above results. — In diagram 3 (Europe—Asia) for inst. the Atlantic gradient in 60° lat. shows the same ratio as found in 50° lat., but having a range of about 27° less; this agrees with the continental gradient of more than double the ratio of that found in the parallel 50° and with the insertion of a Polar gradient between the Continental and Pacific gradients — the natural consequences of the increasing influence of northern and continental factors on the climate in northerly latitudes of Asia.

In the lat. 40° the Atlantic gradient, starting from Valencia in about Greenwich meridian, is dissolved in a Mediterranean and an Intermediate gradient, of a total range similar to the Atlantic gradient in 50°, and continued with a Continental gradient (from Krassnowodsk at the eastern coast of the Caspian sea to Pekin) of the same ratio and consequently parallel to the Continental gradient of 50°.

It is of interest in the diagrams and the notes, accompanying the same, to observe the decrease from North to South in the ratio of the Pacific gradients, and that the range of the Pacific sphere in the Eastern Asia is gaining ground in the southern latitudes at the cost of the Continental ranges.

85° W. 80° 75° 70° 65° 60° 55° 50° 45°

70°

65°

60°

55°

50°

45°

40°

35°

30°

25°

20°

Upernivik
−10,12 ● −8,09 (11) −8,20 (9)
+ 0,68 +2,71 +2,60

Jacobshavn
−5,92 ● −4,91 (11) −5,18 (18)
+2,29 +3,30 +3,03

Godthaab
−2,49 ● −2,90 (13) −1,82(11) −1,88(18)
+1,95 +1,54 +2,63 +2,56

Ivigtut
+0,75 ● +0,84 (11) +1,01 (9)
+2,89 +2,98 +3,15

N.A.
+3,10 ● +1,96
+2,42 +1,28

Nain
−1,97 ● −2,35 (6) −5,73 (3) −5,43 (4)
−3,36 −3,73 −7,11 −6,82

N.A.
+5,36 ● +4,33
+0.88 −0,15

Belle Isle
+1,97 ● −0,74 (2)
−2,37 −5,07

St. Johns N.F.
+6,88 ● +4,98 (15)
−1,04 −2,94

N.A.
+9,19 ● +7,11
+0,99 −1,09

N.A.
+9,50 ● +8,44
−2,28 −3,34

N.A.
+13,87 ● +12,90
+ 2,09 + 1,12

New York
+10,38 ● +10,85 (1) +10,78 (15)
− 2,38 − 1,91 − 1,99

N.A.
+13,84 ● +14,43
− 1,32 − 0,73

N.A.
+17.40 ● +18,03
+ 2,24 + 1,87

Cape Hatteras
+15,65 ● +16,21 (15)
− 0,96 − 0,40

Charleston
+17,34 ● +19,06 (15)
+ 0,68 + 1,04

N.A.
● +18,28
0
+17,83
− 0,45

Bermuda
+18,74 ● +19,67 (1) +21,32 (15)
+ 0.52 + 1,45 + 3,09

N.A.
+19,89 ● +21.31
+ 1,61 + 3,03

N.A.
+21,61 ● +23,40
+ 0.54 + 2,23

N.A.
+21,51 ● +23,29
+ 0,44 + 2,28

Havana
+23,88 ● +25,09 (7) +25.80 (19)
+ 0,77 + 1,99 + 2,69

N.A.
+24,98 ● +25,73
+ 1 49 + 2,24

Christiansted
+26,53 ● +27,19 (9)
+ 1,27 + 1.93

35⁰ 30⁰ 25⁰ 20⁰ 15⁰ 10⁰ 5⁰ 0⁰

70⁰ 65⁰ 60⁰ 55⁰ 50⁰ 45⁰ 40⁰ 35⁰ 30⁰ 25⁰

Jan Mayen
−0,19 ● −2,31 (1)
+9,30 +7,18

Stykkisholm
+2,82 ● +2,85(15) +2,84(38)
+7,95 +7,98 +7,97

Thorshavn
+6,56 ● + 7,56 (3) +6,44(15)
+9,33 +10,33 +9,21

Stornoway
+8,64 ● +7,75(16)
+8,61 +7,72

N.A.
+9,00 ● +9,03
+8,32 +8,35

Glasgow
+9,50 ● +8,26(15)
+7,87 +6,63

N.A.
+11,49 ● +11,71
+ 7,01 + 7,24

Valentia
+10,69(15)
+11,67 + 5,81
+ 6,79

Pembroke
+11,23 ● +10,14(15)
+ 6,37 + 5,28

Brest
+12,30 ● +11,71(15)
+ 5,07 + 4,46

N.A.
+13,35 ● +14,01
+ 5,15 + 5,81

N.A.
+14,48 ● +16,31
+ 2,70 + 4,52

Lisbon
+15,34 ● +16,33(5) +15,49(15)
+ 1,48 + 2,47 + 1,62

St. Michael
+16,30 ● +16,90 (1)
+ 1,30 + 1,90

N.A.
+16,35 ● +17,88
+ 1,18 + 2,72

Gibraltar
+17,33 ● +19,69(2) +18,51(15)
+ 1,37 + 3,73 + 2,55

Funchal
+18,09 ● +19,78(1)
+ 0,01 + 1,71

N.A.
+18,71 ● +20,01
+ 0,43 + 1,74

N.A. Las Palmas
+19,62 ● +21,87 +20,18 ● +20,86 (5)
− 1,45 + 0,80 − 0,87 − 0,18

In North-America (diagram 4) the general track of the curve 50° is perceptible in the 41° section, only, as in Europe—Asia, a depression (flattening) of the Atlantic and Pacific gradients takes place.

The section across the Scandinavian Peninsula in about the lat. 62° (diagram 5) shows exactly the same phenomena as observed in the continental curve 50°. The Pyrenean, the Balkan and other Peninsulæ would in all probability give the same result.

In all the sections of Europe—Asia the eastern points of the diagrams show a higher value of *MV* than the western, and this is also the case in the section 41° of North-America (diagram 4); the section 50° of this continent (diagram 1 and 4) seems to make an exception. but this is only apparently, the western point of the curve, for want of proper statistics, not being carried right through to the Pacific coast.

The north-atlantic coeff. *MV* in the curve 50° are simply the means of those determined for the lat. 52° 30′ and 47° 30′ (Tab. VII).

The calculated positions in the diagrams 1—3 and 6, as well as the corresponding value of *MV*, are determined by means of the ratio of the adjacent gradients and the nearest of the given positions*).

45. The diagrams and statistical data, given on the plans II and III, afford numerous means to control the principles exposed in the preceding paragraph; the Author entertains no doubt, that minute investigations will confirm and complete the general law, the consequence of which will enable the meteorologist to determine in the simplest possible manner the normal value of the physical coefficient *MV* at all intermediate points, on the condition, that the fundamental points and the geographical position of the same have been precisely fixed. A few examples will explain this plan.

33. *Poltava*, long. 34° 38′ E.

calcul. coeff. $MV = 4{,}_{00} + 0{,}_{1568}\,(34^\circ\,38' - 0^\circ\,22') = 9{,}_{37}\,^\circ C$

observed coeff. $MV = \ldots\ldots\ldots\ldots\ldots\ldots\ldots = 9{,}_{20}$

39. *Kjachta*, long. 106° 35′ E.

calcul. coeff. $MV = 12{,}_{23} + 0{,}_{0305}\,(106^\circ\,35' - 52^\circ\,59') = 13{,}_{86}\,^\circ C$

observed coeff. $MV = \ldots\ldots\ldots\ldots\ldots\ldots\ldots = 13{,}_{62}$

39. *Medicine Hat*, long. 110° 37′ W.

calcul. coeff. $MV = 12{,}_{51} - 0{,}_{2420}\,(110^\circ\,37' - 103^\circ\,42') = 10{,}_{84}\,^\circ C$

observed coeff. $MV = \ldots\ldots\ldots\ldots\ldots\ldots\ldots = 10{,}_{61}$

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*) The calculated point of inflexion *(x)* in diagram 1, Pl. II, is for inst. determined by the equations

$$11{,}_{39} + x\,.\,0{,}_{1568} = 13{,}_{05} - y\,.\,0{,}_{0305}$$

$$x + y = 80^\circ\,13' - 47^\circ\,37' = 32^\circ\,36'$$

from which $x = 5^\circ\,16'$

and the position $x = 47^\circ\,37' + 5^\circ\,16' = 52^\circ\,53'$ long.

the corresponding MV $11{,}_{39} + 5{,}_{27}\,.\,0{,}_{1568} = 12{,}_{23}\,^\circ C$

Uralsk is in Chall. Rep. the nearest place to the position x, showing by a long. 50° 55′ a value of $MV = 11{,}_{64}\,^\circ C$. Two degrees further eastward this would give an $MV = 11{,}_{64} + 2\,.\,0{,}_{1568} = 11{,}_{96}\,^\circ C$, only $0{,}_{27}\,^\circ C$ less than the above calculated value of $MV = 12{,}_{23}\,^\circ C$.

The same simple rule does not apply to the Atlantic Ocean, but the correctness of the statistical record in the Chall. Reports being admitted, the determination of the coeff. *MV* in any point will offer no difficulties.

Small deviations of the calculated from the observed coeff. *MV* will probably often occur, and such invite then to further local researches, as does such points (23. 24. and 40. West, diagram 1), which at present take position outside the regular track.

The points 2—24 East, in the same diagram, are of special interest, as the parallelism of this part to the southern coastline of the North sea and the Baltic sea would seem more likely to cause a depression; it appears, however, that a more critical selection of the starting point than just the nearest landing-place of the parallel 50° (2. Fécamp, 49° 46′), and one with probably more settled meteorological elements (Amiens—Arras for inst.) would for this part increase the approximation to the Eastern Atlantic gradient, now principally fixed by the points 2 (Fécamp), 25 (Bardorff, Bohemia) and 36—37 (Kamyschin—Malyi-Usen, Russia).

46. Also in meridional direction a simple relation seems to take place. In proof of this a number of places on both sides of the meridian 90° West, in the southern part closely bordering the river Mississippi, has been selected and the positions, the actually observed as well as the calculated coefficients *MV* compared to the statistical data.

Movement of the thermo-geographical coeff *MV* in meridional direction.

The following table shows the effect of the reduction of the actually observed *MV* for special determined parallels to the meridian 90° West by means of the Atlantic gradients for 50° and 41° lat., by the meridional ratio (increase) from New Orleans to Winnipeg, and the following re-calculation of *MV* from 90° W. to the proper long. of the place.

	Observations				*MV*1 parallel reduction to 90° W.	*MV*2 meridional reduction in 90° W.	Means of *MV*1 and *MV*2	*MV*3 Re-calculation to *MV*$_\lambda$	*MV*3 − *MV*
	φ	λ	*H*	*MV*					
1. York Factory ..	57° 0′	92° 28′	17	14,3042 °C	13,93	15,15	14,54	14,94	+ 0,64 °C
2. Winnipeg	49° 55′	97° 7′	226	12,9055	12,50	12,50	12,50	12,66	— 0,25
3. Bismarck	46° 47′	100° 36′	516	11,0407	11,25	11,32	11,29	11,21	+ 0,17
4. Saint Pauls ..	44° 58′	93° 3′	244	10,4882	10,54	10,65	10,60	10,97	+ 0,48
5. Chicago	41° 52′	87° 38′	201	8,5100	9,32	9,48	9,40	9,22	+ 0,71
6. Omaha	41° 16′	95° 56′	339	9,5400	9,08	9,26	9,17	9,63	+ 0,09
7. Saint Louis ..	38° 27′	90° 12′	174	8,2200	8,22	8,21	8,22	8,22	0
8. Cairo	37° 0′	89° 10′	115	7,6200	7,62	7,66	7,64	7,64	+ 0,02
9. Memphis	35° 9′	90° 3′	10	7,0817	7,08	6,97	7,03	7,03	— 0,05
10. New Orleans ..	29° 58′	90° 4′	16	5,0200	5,02	5,02	5,02	5,02	0

From the inconsiderable differences it may be concluded, that the mighty river, although running North—South, does not exercise any perceivable influence on the movement in the temperature, whilst the circumstance, that the observed coeff. *MV* for the places

York Factory and Chicago is respectively $0{,}64^0$ and $0{,}71^0$ lower than the coefficients derived from the general ratio, no doubt is attributable to the situation of the two places immediate at the shores of Hudson Bay and the great lakes.

The observations in §§ 45 and 46 in respect to the North sea, the Baltic sea and the river Mississippi, which show no traceable influence on the coefficient *MV* of places situated along the same, appear fully explicable by the moderate depth of these waters (§ 28, the Caspian Sea).

General remarks on the relation of the thermo-geographical coeff. *MV* to the Atlantic Ocean and the Gulf stream.

47. There are still several moments of geographical interest to be observed in the movement of the physical coefficient. From the diagram 1, Plan II, it will namely be seen, that in the eastern Atlantic gradient the place *Ssoschanskoe* (30), at a distance of $28^0\ 33'$ long. from the Atlantic, has exactly the same coefficient ($8{,}22\ ^0$C) as the starting point of the western Atlantic gradient (long. $64^0\ 20'$) at the coast of the American continent; it will further be observed, that both the Atlantic gradients from these points to the continental point of inflexion have about the same length, namely

in North-America		*in Europe*	
30. Stony Mountain	$91^0\ 40'$	the point of inflexion x	$52^0\ 59'$
coast	$64^0\ 20'$	30. Ssoschanskoe	$28^0\ 55'$
distance . . =	$27^0\ 20'$	distance . . =	$24^0\ 4'$

and further, that the Atlantic gradients finish with the coefficients $12{,}78^0$ and $12{,}23^0$ respectively, or with about the same value.

A revision of these data might possibly give more equal results, but the figures, as they are, allow no doubt an attempt to distinguish between the effect of the Ocean itself and of the surplus of this effect, visible in the eastern gradient and principally due to the Gulf stream. — It seems namely most probable, that a deep, stagnant Ocean, at its shores and in the same latitude would produce the same value of the coefficient *MV*, and the displacement of the starting West-Atlantic coefficient $8{,}22$ to a continental place in the East-Atlantic gradient, distant $28^0\ 33'$ long. from the East-Atlantic coast, is therefore doubtless the resultant in the parallel 50^0 lat. of the eastward action of the Gulf stream and its consequences; the rest of the East-Atlantic gradient, calculated to about 24^0 long., or of nearly the same length as the West-Atlantic gradient, is then due to the effect of the deep ocean, the general regulator of the movement in temperature over the adjacent continents. — This distinction of the Atlantic factors is strengthened by the fact, that in the West-Atlantic gradients similar coefficients, as the above $8{,}22$ at the western shores of the gulf of Lawrence, are found along the coast of North-America in the places Concorde ($8{,}22$), Boston ($8{,}00$), New London ($7{,}69$), New York ($8{,}05$) down to Washington ($7{,}98$); a comparison with places in Europe, which, according to the above definitions and to the coefficients *MV*, are situated within reach of the Gulf stream sphere, gives the following interesting results:

	φ	λ	MV	the Gulf-stream sphere	
Kem	64°57′	34°39′	$8,_{19}{}^{0}$	34°39′—12°30′ = 22° 9′	= 1045 Kilometres
St. Petersburg . .	59°56′	30°16′	$8,_{61}$	30°16′— 5°30′ = 24°46′	= 1381 —
Weliki—Luki*) . .	56°21′	30°31′	$8,_{37}$	= 26°40′**)	= 1649 —
Ssoschanskoe	49°34′	28°55′	$8,_{22}$	28°55′— 0°22′ = 28°33′	= 2068 —

This survey indicates a decrease in the linear extension***) of the Gulf-stream sphere from 2068 Kilometres in the parallel 50° to about the half of this distance or 1045 Kilometres in the parallel 65°. At first sight this result seems somewhat surprising, as the thermal force of the Gulf-stream itself rather increases towards North (Tab. II, Plan I), but the above limitation is nevertheless in all probability correct, and fully explained by the change in the direction of the stream, within these latitudes almost parallel to the meridians, by the resistance offered by the range of mountains (Kjølen), parallel to the coast of Norway, and principally by the encounter with the northern continental forces. The combined effect of these conditions may possibly produce the said reduction in the continental sphere of the Gulf stream (from lat. 50° to 65°), as approximately measured by the thermo-geographical coefficients.

In parallels south of Ssoschanskoe the continuation of the Atlantic influence by the Mediterranean, the Black sea and the Caspian sea becomes prominent in the coeff. MV, of which the Odessa ($8,_{17}{}^{0}$), the Krassnowodsk ($8,_{17}$) and the Bagdad ($8,_{08}$) enter these reflections.

48. The height of the place of observation has not hitherto been taken into consideration, chiefly on the ground, that most of the places are situated at moderate heights, within which, according to preliminary examinations, no or but a very small reduction in the value of the coeff. MV can be traced.

Relation of the thermo-geographical coeff. MV to heights in the Alpine regions.

The question of the influence on the temperature of the height over sea-level, or of the vertical distances in the different formations of the ground, is, however, one of the problems, which of late have become more prominent in meteorological researches, and also for this reason the attempt should be made to ascertain, by means of the

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*) This place is found by the following raisonnement. On the map, near the parallel 55°, the places Wilna ($7,_{60}$) and Moscow ($9,_{31}$) are noted of which the means of long. and coeff. give $\lambda = 31°25'$ and $MV = 8,_{45}{}^{0}$. — In Chall. Rep. the place on record nearest 55° lat. and 31°25′ long. is Weliki—Luki, the coeff. MV of which was found $= 8.{}_{37}{}^{0}$.

**) As the parallel 55° (56°21′) strikes right across the North sea and the Baltic sea no exact coast-station or starting point can be fixed; the length of 26°40′ is therefore the means of thc lengths due to St. Petersburg and Ssoschanskoe. This length places the starting point at about 4° E. or in the middle of the North sea, which seems to agree well with the shallowness of the North and the Baltic sea.

***) The linear measurement conveys in these researches, comprising 15° lat., a more correct idea of the real extent of the phenomenon, than the angular distances.

general statistics of temperature, the vertical relations of the physical coefficient, all due reservations being taken in regard to results obtained under conditions, in which the exactness in the eventual definition, on account of the small quantities to be dealt with, is placed in marked contrast to the general variations and uncertainties in the statistics.

The difficulties to be overcome are of complicated nature; the difference in *MV* caused by the difference in height of a peak-like mountain and a neighbouring deep and narrow valley, as for inst. Obirgipfel—Klagenfurt, would presumably yield another ratio, than that obtained from observations on elevated plateaux and in undulating countries; seeing, that physical causes, combined with the geographical positions and the observations themselves, influence the determination, it will be the more interesting to prove the working of the coefficient *MV* in respect to height and in territories, presenting different formations and observations in sufficient number and variety.

Accordingly the region of 45—48° lat. and 7—14° long. of the Mediterranean countries, comprising the Northern Italy and the limitrophe Alpine districts, has been selected to serve for the above attempt, especially because the moderate heights in the southern zone of this region, under the parallel action of the Mediterranean and the Adriatic, and the numerous stations spread over a small area offer favourable conditions for the establishment of a fair niveau for the comparison with elevated stations in or near the same zones. The diagram 2, Plan II, represents the above territory and the geographical position of 30 places in the same, all of which are enumerated in the diagram and in the accompanying table on the plan, giving the geographical position of each place, the height and the coefficient *MV*, according to the Challenger Reports. The diagram and the table contain all particulars of 4 stations over 2000 metres height, to viz.

8, Säntis	2468 m.	19, Great St. Bernard ..	2482 m.
12, Obirgipfel	2044 m.	21, Valdobbia	2549 m.

and of 26 stations at heights varying from 9 to 590 metres over the sea-level.

The 30 stations were first classified according to height, and the means of height and *MV* determined as follows:

		means of height	means of *MV*
Under 100 m. ..	9 stations ..	48 m. ..	$6_{,6996}$ °C
100—200 m. ..	3 stations ..	125 m. ..	$6_{,6043}$
200—300 m. ..	5 stations ..	281 m. ..	$6_{,2421}$
300—400 m. ..	1 station ..	384 m. ..	$6_{,4444}$
400—500 m. ..	5 stations .	433 m- ..	$6_{,5467}$
500—600 m. ..	3 stations ..	564 m. ..	$6_{,1039}$
over 2000 m. ..	4 stations ..	2386 m. ..	$4_{,8727}$

This scheme shows a decided, although moderate and oscillating decrease in the coeff. *MV*, the probable relation of which to the height may be determined by the following proceedings.

Excluding, on account of anomalies in the means, the 6 stations from 300 to 500 m., the remaining 20 stations under 600 metres height served for ascertaining a provisional niveau of 195 metres and a corresponding mean coefficient $MV = 6{,}_{4815}\ ^0C$*).

In the same manner the 12 stations, situated in the southern zone 45—46° lat., all of inconsiderable height and from their situation probably equally exposed to the dominating Mediterranean forces, give a niveau of 81 metres and the corresponding $MV = 6{,}_{7028}\ ^0C$**).

A similar proceeding for the zone 46—47° lat. gives for 6 stations (11, Klagenfurt excluded) the means of heights and coefficients respectively 374 metres and $6{,}_{2849}\ ^0C$***) — and for the zone 47—48° lat. the means 401 metres and $6{,}_{1014}\ ^0C$****).

Besides the above means of height and corresponding coefficient, namely:

	Height	MV
General means	195 m.	$6{,}_{4815}\ ^0C$
Means of the parallel-zones		
45—46° lat.	81 m.	$6{,}_{7028}$
46—47° lat.	374 m.	$6{,}_{2849}$
47—48° lat.	401 m.	$6{,}_{1014}$

the special relation of each of the 4 elevated stations to the nearest of the level stations may also be taken into account as follows:

8, Säntis and means of 5, Friedrichshafen and 10, Chur.
12, Obirgipfel and 11, Klagenfurt.
19, Great St. Bernard and 29, Turin.
21, Valdobbia and 29, Turin.

The mean ratio in decrease of the coefficient MV corresponding to 1000 metres ascent, obtained by the different proceedings, are now calculated and classified as follows:

	General means	Parallel-zones	local levelling
8, Säntis	$0{,}_{8840}\ ^0C$	$0{,}_{7882}\ ^0C$	$0{,}_{8108}\ ^0C$
12, Obirgipfel	$0{,}_{8212}$	$0{,}_{7916}$	$1{,}_{7364}$
19, Gr. St. Bernard	$0{,}_{6154}$	$0{,}_{6783}$	$0{,}_{7093}$
21, Valdobbia	$0{,}_{6372}$	$0{,}_{6975}$	$0{,}_{7292}$
Means .. =	$0{,}_{7395}$	$0{,}_{7389}$	$0{,}_{7498}\ ^0C$

*) Namely .. 9 Obs. (17. 18. 22. 23. 24. 26. 27. 28. 30.) .. total height 432 m. .. total MV $60{,}_{2963}$
3 Obs. (14. 20. 25.) .. .. 375 m. .. $19{,}_{8130}$
5 Obs. (3. 6. 15. 16. 29.) .. .. 1407 m. .. $31{,}_{2103}$
3 Obs. (1. 9. 10.) .. .. 1692 m. .. $18{,}_{3116}$
total = 20 Observations = 3906 m. .. = $129{,}_{6312}$
Means = 195 m. = $6{,}_{4815}$

**) Namely .. 12 Obs. (17. 18. 20. 22.—30.) .. .. .. 967 m. .. $80{,}_{4334}$
Means = 81 m. = $6{,}_{7028}$

***) Namely .. 6 Obs. (9. 10. 13. 14. 15. 16.) .. .. .. 2245 m. .. $37{,}_{7096}$
Means = 374 m. = $6{,}_{2849}$

****) Namely .. 4 Obs. (4. 5. 6. 7.) .. .. 1602 m. .. $24{,}_{4055}$
Means = 401 m. = $6{,}_{1014}$

In the last column the ratio $1{,}7364\ ^0$C, due to Obirgipfel—Klagenfurt, is excluded*), all the others being sufficiently conform to produce a fair average or approximation to the normal mean-ratio; in the Alpine regions the normal ratio of decrease in the coeff. *MV* per *1000 metres ascent* may accordingly be taken $= 0{,}75\ ^0C$.

From the southern zone the coeff. *MV* corresponding to the sea-level is now found $= 6{,}7028 + 0{,}0608 = 6{,}7636\ ^0$C, and starting from these relations the following Alpine scales have been constructed.

$H =$	$MV =$	$MV =$	$H =$
0	$6{,}7636\ ^0$C	$6{,}7636\ ^0$C	0
500 metres	$6{,}3886$	$6{,}0000$	1018 metres
1000 —	$6{,}0136$	$5{,}0000$	2351 —
2000 —	$5{,}2636$	$4{,}0000$	3685 —
2500 —	$4{,}8886$	$3{,}0000$	5018 —
3000 —	$4{,}5136$	$2{,}0000$	6351 —
4000 —	$3{,}7636$	$1{,}0000$	7685 —
5000 —	$3{,}0136$	0	9018 —

Starting from $MV = 6{,}7636\ ^0$C at the sea-level and applying the scale, equal to a decrease $= 0{,}75\ ^0$C to 1000 metres ascent, the following table compares the observed and the calculated value of the coefficient *MV* for the 30 places in the Alpine regions, named on Pl. II, diagram 2.

		m.	*MV* obs.	*MV* calcul.	Diff. calcul.-obs.		m.	*MV* obs.	*MV* calcul.	Diff. calcul.-obs.
1	Munich	529	$6{,}2315$	$6{,}3668$	$+0{,}135$	16	Lugano	275	$6{,}0648$	$6{,}5573$	$+0{,}493$
2	Kremsmünster	384	$6{,}4444$	$6{,}4756$	$+0{,}031$	17	Görz	94	$6{,}0370$	$6{,}6931$	$+0{,}656$
3	Freiburg	291	$5{,}8333$	$6{,}5453$	$+0{,}712$	18	Riva	84	$6{,}1111$	$6{,}7006$	$+0{,}590$
4	Salzburg	436	$6{,}4452$	$6{,}4366$	$-0{,}009$	19	Gr. St. Bernard	2482	$5{,}0742$	$4{,}9021$	$-0{,}172$
5	Friedrichshafen	408	$5{,}9815$	$6{,}4576$	$+0{,}476$	20	Como	112	$6{,}5000$	$6{,}6796$	$+0{,}180$
6	Basel	278	$5{,}9418$	$6{,}5551$	$+0{,}613$	21	Valdobbia	2549	$4{,}9815$	$4{,}8518$	$-0{,}130$
7	Zürich	480	$6{,}0370$	$6{,}4036$	$+0{,}367$	22	Trieste	26	$6{,}1852$	$6{,}7441$	$+0{,}559$
8	Säntis	2468	$4{,}4722$	$4{,}9126$	$+0{,}440$	23	Vicenza	56	$6{,}8426$	$6{,}7216$	$-0{,}121$
9	Berne	573	$5{,}9260$	$6{,}3338$	$+0{,}408$	24	Venice	21	$6{,}6667$	$6{,}7478$	$+0{,}081$
10	Chur	590	$6{,}1541$	$6{,}3211$	$+0{,}167$	25	Milan	147	$6{,}9982$	$6{,}6533$	$-0{,}345$
11	Klagenfurt	438	$7{,}7516$	$6{,}4351$	$-1{,}317$	26	Padua	34	$6{,}7037$	$6{,}7381$	$+0{,}034$
12	Obirgipfel	2044	$4{,}9630$	$5{,}2306$	$+0{,}268$	27	Mantua	40	$7{,}3518$	$6{,}7336$	$-0{,}618$
13	Belluno	404	$6{,}5184$	$6{,}4606$	$-0{,}058$	28	Cremona	68	$7{,}2222$	$6{,}7126$	$-0{,}510$
14	Udino	116	$6{,}3148$	$6{,}6766$	$+0{,}362$	29	Turin	276	$6{,}6389$	$6{,}5566$	$-0{,}082$
15	Laibach	287	$6{,}7315$	$6{,}5483$	$-0{,}183$	30	Rovigo	9	$7{,}1760$	$6{,}7568$	$-0{,}419$

*) It is evidently the Klagenfurt coefficient, which is the exceptional one; the normal coefficient corresponding to the height of this place is calculated to $6{,}44\ ^0$C, and the difference from the obs. coeff. $(7{,}75) = 1{,}31\ ^0$C seems then to be attributable to the special nature of the environs of the station at Klagenfurt.

With the exception of Klagenfurt the differences will be found but small and inconsiderable, particularly for the more elevated stations; in some places, differently situated, the difference is even next to nil; although the basis or the scale in this region tends to give coefficients, which at an average are a trifle higher than the observations, the method seems applicable at other places, especially as the effect of the differences is of little consequence, when compared to that of the coefficients themselves and to other factors entering the complete formulæ for the months.

The relation of height to the coefficient *MV*, represented in the Alpine scale, gives the result, that at a height of about $7^1/_2$ Kilometres, or one geographical mile, the movement of temperature is governed solely by the dynamo-cosmical factors, and that the year round a constant temperature prevails at a height of about 9 Kilometres. — Particularly this last result is of interest, as this limit of the effective atmosphere agrees well with the height of 10 Kilometres, adopted by several Authors in recent researches on the relation of the atmosphere to heat and light*).

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*) Die Vertheilung der Värme auf der Erdoberfläche, page 29. Gekrönte Preisschrift von Dr. Wilhelm Zenker, Berlin, 1888.

VI.

SUPPLEMENTARY RESEARCHES ON THE DISTRIBUTION OF TEMPERATURE OVER THE SURFACE OF THE GLOBE.

Introductory remarks on the supplementary researches in reference to the completion of the thermo-geographical formulæ.

49. The equations of temperature, dealt with in part I—V, comprise all the numerical formulæ and coefficients required for the analytical determination of

the normal mean yearly temperature of any parallel of the Northern and Southern Hemisphere,

the mean yearly temperature of any place of the Atlantic middle-zones, forming one-half part of the Northern Hemisphere, and

the normal mean monthly temperature of any place of the temperate and polar zone of the Northern Hemisphere;

consequently the completion of this system requires the construction of equations and formulæ for determining

the mean yearly temperature of any place of the Pacific middle-zones of the Northern Hemisphere and of any place of the Southern Hemisphere, and

the normal mean monthly temperature of any place of the tropical zone and of the Southern temperate and polar zone.

As far as regards the analytical determination of the mean yearly temperature of places situated outside the North-Atlantic middle-zones, the further application of the partial system appears likely to produce more stringent working formulæ than already obtained, but there is also room for the remark, that the less complicated configuration of that part of the earth's surface eventually may permit the introduction of still simpler formulæ, at least as far as the Pacific regions are concerned.

The factors and coefficients have all been analytically or theoretically determined with the exception of one of the monthly terms, the thermo-geographical coefficient MV; according to the special researches (part V and VII) the numerical value of

this factor may, however, be readily determined by starting from certain directing main-points (points of inflexion), the geographical position and numericals of which only require reliable statistical records to be precisely ascertained. The special methods dealt with in the Alpine and Arctic regions may also be found applicable to researches in other districts. At present the coefficient MV is only statistically determined.

According to the above remarks, and for the purpose of completing the system of analytical thermo-geographical formulæ, the Author now proposes to produce in the present part VI the result of supplementary researches, particularly dealing with the distribution of temperature over the tropical zone and the temperate zone of the Southern Hemisphere, but also comprising certain general representations of the movement of temperature over the Globe.

From the accompanying 6 tables X—XV, named below, it will be seen, that the Author has succeeded in his efforts to generalize the terms of the formulæ for the months, and they will at the same time enable the readers in a convenient manner to follow and to some extent to control the application and effect achieved by the introduction of some new views on the subject, which, it is hoped, will be found confirming former considerations, and throw fresh light upon the movement of temperature over the globe. The above mentioned tables are entitled as follows:

Tab. X. Showing the numerical values and signs of the term $\frac{6\ Q_m}{\Sigma\ (+\ Q_m)}$, and the corresponding thermal order of the Months for the polar and temperate zone of both Hemispheres, as well as for several main parallels of the tropical zone.

Tab. XI. Comparison of the actually observed and the calculated normal monthly temperature, the corresponding meteorological series and the displacement of the Months for various places, situated in the polar and temperate zone of the Northern Hemisphere.

Tab. XII. Comparison of the actually observed and the calculated normal monthly temperature, the corresponding meteorological series and the displacement of the Months for various places, situated in or near several main parallels of the tropical zone.

Tab. XIII. Comparison of the actually observed and the calculated normal monthly temperature, the corresponding meteorological series and the displacement fo the Months for various places, situated in the temperate zone of the Southern Hemisphere.

Tab. XIV. Geographical distribution of the total sum of the meteorological series $= \Sigma\ (\pm\ \Delta_m)$, as determined by the difference of the observed and the normal temperature of each month for the places, specified in Tab. XI, XII and XIII.

Tab. XV. General prospect and comparison of the observed and the normal movement of temperature, as determined for 407 places, situated in the polar, temperate and tropical zone of the Northern and Southern Hemisphere.

The data in the above tables are all taken from the Challenger Reports, the temperature is in Tab. XII and XIII given in degrees Fahrenheit, but in Tab. XI, XIV and XV in degrees Centigrade.

Special remarks on the formulæ for the Year and the Months.

50. The specification of the tables gives the information, that in this continuation of the thermo-geographical studies no attempt is made to complete the „formulæ for the year"; the operations themselves offer no difficulties, and it is easy to see, that the analytical system, when the doubt as to the true mean yearly temperature of the fundamental positions shall have been removed and when a sufficient number of observations is at disposal, by the method employed is certain to reproduce the *standard temperature for the year* of any place, and afford the means correctly to divide the total amount of the mean yearly temperature into the parts due to the latitude, the thermo-geographical component and the height over the sea-level of the particular place.

In respect to the temperature of the Months, or more correctly, to the distribution of the mean yearly temperature over the Months, the analytical researches are not yet so far advanced; the normal temperature of the Months are at present determined by means of the functions MV, Q_m and M in such a combination, that the terms MV and M (the original mean yearly temperature of the place) are reproduced. From the researches on the function MV (part III and V) it will be remembered, that the same principally represents the continentality of the place and also its physical nature, as far as the movement in the temperature is acted upon by the same. The further analysis of the term MV requires continued local studies of the difference of the observed and the calculated, normal temperature, and as now this difference from natural causes is of greater numerical value in certain tropical regions than as a rule in the temperate zones, the Author has in this continuation of the researches taken the occasion to devote special attention to this quantity.

In conclusion, the rest arising from the calculated yearly temperature is principally of analytical interest, whilst the rest arising from the present formulæ for the Months points to factors of considerable geo-physical and meteorological importance.

In consequence of the above arguments the *observed* mean yearly temperature is taken as the fundamental quantity for the researches represented in the Tables XI—XIII; the complications caused by simultaneous comparison to the calculated yearly *and* monthly temperature are thus avoided, and the question of the *normal* temperature of the Months referred to a suite of researches, from which the analytical determination of the mean yearly temperature has been removed.

51. The leading principles in the present attempts to construct the formulæ for the analytical determination of the normal, monthly temperature of places, situated within the *tropical zone,* require, that the formulæ, for the sake of convenience in their application, be composed in uniformity with those, constructed for the temperate and polar zones of the Northern Hemisphere.

Remarks on the generalization of the formulæ for the Months.

The thermo-geographical coefficient MV represents therefore the same annual function in the tropical as in the temperate zone; until analytically determined, this factor is derived from series of actual observations, in the same manner as described in part III, and from the formula $MV = \frac{\Sigma(+ t_m) - 6\,M}{6}$.

The retarded position of the sun, referred to the chronological centre of each month, is likewise maintained as the fixed position, which in combination with the latitude of the particular tropical parallel or place affords the means for calculating the corresponding numerical factor Q_m. The different values of this function and of the term $\frac{6\,Q_m}{\Sigma(+ Q_m)}$ represent then for each month the successive transition from the Northern to the Southern temperate zone, and for the tropical parallels the characteristic motion in the suns position, twice a year appearing North or South of or in Zenith over the same parallel.

It is this motion, peculiar for the tropical Zone, which makes the argument, expressed in the relation for the northern temperate Zone, $Q_m = \frac{t_m - M}{t_7 - M}$, incorrect for general purposes, because the term t_7 in fact does not particularly signify the seventh calendar-month, but that month, in which the sun attains its retarded max. of altitude. The generalized and true meaning of the term t_7 in the above expression necessitates the introduction of another classification in the series of temperature than the usual calendar order, namely *„the thermal order of the Months“*, divided as usual into the two categories, the „normal“ and the „observed“ order. Accordingly, in the present researches the term t_1 means in observed series the month of the highest temperature, and in normal series that month, in which the sun attains the retarded highest position, t_2, t_3 . . . . the next in the order and t_{12} the month occupying the lowest thermal position in the series.

The thermal order of the Months.

The classification of the months according to the thermal order is without any inconvenience applicable in all researches concerning series of temperature, and the comparison of the observed to the normal order, giving for the year and the place the *„total displacement“*, will be found to afford evidences and details of considerable importance in the general meteorological service. The whole proceeding in this investigation is fully explained in the following.

According to the numericals and signs of the term $\frac{6\,Q_m}{\Sigma(+ Q_m)}$ the following is the normal order of the Months in the polar and temperate Zone of the Northern and Southern Hemisphere,

	Jan.	Febr.	March	April	May	June	July	Aug.	Sept.	Octob.	Novbr.	Decbr.
North. Hemisphere												
normal order	12	11	9	7	5	3	1	2	4	6	8	10
South. Hemisphere												
normal order	1	2	4	6	8	10	12	11	9	7	5	3

Displacement and total displacement of the Months.

The „displacement“ is the difference for each month of the observed and normal order, and the „total displacement“ the sum for the year of the displacement of all the months, as for inst. for *Upernivik* (4, Tab. XV):

	Jan.	Febr.	March	April	May	June	July	Aug.	Sept.	Octob.	Novbr.	Decbr.	total displacem.
observed order	11	12	10	8	5	3	1	2	4	6	7	9	
normal order	12	11	9	7	5	3	1	2	4	6	8	10	
displacement	1	1	1	1	0	0	0	0	0	0	1	1	= 6

As a measurement for the „total displacement“ we may take the max. difference, which results from the comparison of the normal order of the Northern temp. Zone to that of the Southern temp. Zone, and which from the above table amounts to a total of 72, namely:

respectively	11	9	5	1	3	7	11	9	5	1	3	7	= 72

As will be seen from Tab. XV only a very moderate or no displacement is observed in the temperate and polar Zones; the displacement increases, however, towards the Equator and in *Lado* (Eastern Africa, 5° N., 281, Tab. XV) a maximum of total displacement is found, amounting to 62. The cause of the larger displacement under the Tropes is, however, as a rule, Monsoon districts excepted, only of „arithmetical“ nature, which will appear from observations in the following paragraphs.

The dynamo-cosmical coefficient determined for tropical and southern latitudes.

52. After the above introductory remarks on the „tropical“ coefficients, and the „thermal order“, the Author shall proceed to expose the method adopted for determining the numerical term $\frac{6\,Q_m}{\Sigma(+\,Q_m)}$, given in Tab. X for the principal tropical parallels, which also applies to researches on the series of monthly temperature of any tropical place.

From the relations referred to in part III the retarded altitude of the sun over the plan of the Equator is for the month m determined by the formula

$$P_m = arc\ sin\ \omega\ .\ sin\left(L_m - 30{,}_{43485}\,\frac{V_m + V_{m-1}}{2}\right) \ldots\ \ 9\ (\S\ 20),$$

from which, together with the numericals given in the same part, we get for the chronological centre of each month the corresponding P_m, to viz.

January . . .	23° 22′ S.	May	10° 2′ N.	September . . .	13° 49′ N.
February . . .	21° 6′ S.	June	19° 10′ N.	October . . .	2° 42′ N.
March	13° 6′ S.	July	23° 21′ N.	November . . .	9° 1′ S.
April	1° 38′ S.	August	21° 15′ N.	December . . .	18° 43′ S.

If now for the sake of simplification the function $sin\ P_m$ is regulated in proportion to Q_m, $sin\ P_7$ maintained as basis, i. e. $sin\ P_m^1 = Q_m\ .\ sin\ 23^0 21'$, then we obtain the following series, in which

$$\frac{sin\ P_1^1}{sin\ P_7} : \frac{sin\ P_2^1}{sin\ P_7} : \frac{sin\ P_3^1}{sin\ P_7} : \ldots \frac{sin\ P_{12}^1}{sin\ P_7} = Q_1 : Q_2 : Q_3 \ldots Q_{12};$$

the following scheme gives the details of this operation.

	P_m	$sin\ P_m$	$sin\ P_m^1$	$arc\ sin\ P_m^1$	$Q_m = sin\ P_m^1$ in ratio to $sin\ P_7^1 = 1{,}0000$
January . . .	23° 22′ S.	−0,39658	−0,42422	25° 6′ S.	= −1,07024
February . . .	21° 6′ S.	−0,35987	−0,34775	20° 21′ S.	−0,87730
March	13° 6′ S.	−0,22651	−0,23677	13° 42′ S.	−0,59733
April	1° 38′ S.	−0,02835	−0,02819	1° 37′ S.	−0,07111
May	10° 2′ N.	+0,17419	+0,17582	10° 7′ N.	+0,44356
June	19° 10′ N.	+0,32823	+0,31781	18° 31′ N.	+0,80177
July	23° 21′ N.	+0,39638	+0,39638	23° 21′ N.	+1,00000
August	21° 15′ N.	+0,36246	+0,36539	21° 25′ N.	+0,92181
September . . .	13° 49′ N.	+0,23884	+0,23636	13° 40′ N.	+0,59630
October	2° 42′ N.	+0,04722	+0,04912	2° 49′ N.	+0,12392
November . . .	9° 1′ S.	−0,15685	−0,16084	9° 15′ S.	−0,40577
December . . .	18° 43′ S.	−0,32085	−0,34311	20° 4′ S.	−0,86561

The „improved“ latitudes P_m^1 show at once the particular latitude and month, in which the retarded sun reaches its Zenith*), in July at the lat. 23°21′ N., in March at 13°42′ S. etc. This position refers to the Equator, but for any tropical latitude the position of the sun in any month is given by the formula $P_m^{11} = (P_m^1 \mp \varphi)$, in which $-\varphi$ denotes a northern and $+\varphi$ a southern latitude, the position of the sun north and south of the equatorial plan being marked respectively + and —. It

*) The word means here max. of thermal power. — It is of interest to see, that by this regulation the Tropic of Capricorn is extended to the lat. 25° 6′ or about 1° 44′ further south; thus the higher „improved“ latitude of January and December transfers the effect of the perigee at the commencement of January. — For the other months the difference of P_m^1 and P_m is of less importance.

follows, that in the combination, in which P_m^{11} becomes $= 0$ or nearest the same, the particular month takes the position t_1 in the normal series of temperature for that place, and generally, that the thermal order of the months is in reverse proportion to $sin\ P_m^{11}$, that is, in direct proportion to the Zenith-distance. If we now further introduce the mean of the series of $sin\ P_m^{11} = \frac{\Sigma(sin\ P_m^{11})}{12}$, then the difference $= \left(\frac{\Sigma(sin\ P_m^{11})}{12} - sin\ P_m^{11}\right)$ gives the series of positive and negative quantities, which converted in ratio to the Zenith-month $= 1{,}0000$ gives the numericals and signs of the coefficient Q_m and the term $\frac{6\ Q_m}{\Sigma(+\ Q_m)}$, corresponding to the latitude φ. Consequently the formula for determining these factors for the tropical Zone assumes the form

$$Q_m = \frac{0{,}0833\ \Sigma(sin\ P_m^{11}) - sin\ P_m^{11}}{0{,}0833\ \Sigma(sin\ P_m^{11}) - sin\ P_1^{11}} \quad \ldots\ldots\ (14),$$

in which the terms P_1^{11}, P_m^{11} and Q_m refer to the positions and the thermal order in the series of temperature defined in the preceding paragraph.

The following scheme examplifies the above operations applied to the parallel 17° 30′ South.

	$P_m^{11} = (P_m^1 + 17°30')$	$sin\ P_m^{11}$	thermal order	$0{,}0833\Sigma(sin\ P_m^{11}) - sin\ P_m^{11}$	Q_m Decemb. $= 1{,}0000$	$\frac{6\ Q_m}{\Sigma(+\ Q_m)}$
January ..	7° 36′	0,13226	4	+0,19347	+0,68863	+0,9330
February ..	2° 51′	0,04972	2	+0,27601	+0,98242	+1,3311
March	3° 48′	0,06627	3	+0,25946	+0,92351	+1,2513
April	15° 53′	0,27368	6	+0,05205	+0,18526	+0,2510
May	27° 37′	0,46355	8	−0,13782	−0,49055	−0,6646
June	36° 1′	0,58802	10	−0,26229	−0,93358	−1,2649
July	40° 51′	0,65408	12	−0,32835	−1,16871	−1,5834
August	38° 55′	0,62819	11	−0,30246	−1,07656	−1,4586
September ..	31° 10′	0,51753	9	−0,19180	−0,68268	−0,9250
October ..	20° 19′	0,34721	7	−0,02148	−0,07645	−0,1036
November ..	8° 15′	0,14349	5	+0,18224	+0,64866	+0,8789
December ..	2° 34′	0,04478	1	+0,28095	+1,00000	+1,3549
	$\Sigma(sin\ P_m^{11}) = 3{,}90878$			+1,24418	$\Sigma(\pm\ Q_m)$ +4,4285	+6,0000
	$\frac{\Sigma(sin\ P_m^{11})}{12} = 0{,}32573$			−1,24420	−4,4285	−6,0000

Tab. X.

Tab. X contains for 19 main parallels of the tropical Zone the numerical terms, $\frac{6\ Q_m}{\Sigma(+\ Q_m)}$, successively derived from the fixed positions P_m^1 of the sun, together with the thermal order in the corresponding series of temperature. The figures correctly represent the undulating movement in the series of temperature observed in the tropical

Zone, and also the quality it has, to form the connecting link between both of the temperate Zones. Besides, the formula and the plan produced make the method in a convenient manner applicable for practical use in the meteorological service.

The advantages aimed at in the efforts made to generalize the formula

$$t_m = MV \frac{6\ Q_m}{\Sigma(+\ Q_m)} + M \quad \ldots\ \ldots\ \ldots \quad (12)$$

are thus obtained. That the numerical quotient $\frac{6\ Q_m}{\Sigma(+\ Q_m)}$ for the northern temperate Zone simply by change of signs becomes direct applicable to the southern temperate Zone, notwithstanding the transfer of the terms t_1 and Q_1 from July to January, has already been mentioned, and is due to the fact, that Q_m and $\Sigma(+\ Q_m)$ are reduced in the same proportion; on account of this relation the term $\Sigma\left(\frac{6\ Q_m}{\Sigma(+\ Q_m)}\right)$ remains constant and $= \pm 6{,}0000$, thus offering excellent means of control for the computation. The variations otherwise observeable in the tropical dynamo-cosmical functions are due to the variations in the fundamental quantities, to viz. the regular decrease towards the Equator of the sum and means of $sin\ P_m^{11}$, combined with the irregular movement in the Zenith-distance, corresponding to the chronological centre of the month t_1.

Considerations on the normal movement of temperature over the tropical zone.

Tab. X.

53. Tab. X gives a graphic and instructive prospect of the normal distribution of the mean yearly temperature over the tropical and the adjoinant temperate Zones; the general movement of temperature is clearly shown by the application of figures in red and blue (black), representing the positive and negative months. Some of the more characteristic features of this plan shall here be named.

Reckoned from the Tropics towards the Equator it will be seen, that up to about the lat. 10° N. and S. the + and — months form two consecutive series, but that from about this latitude, and towards the Equator, this order is broken by the insertion of respective negative and positive months in such manner, that under the Equator the series of the months is divided in 4 equal parts, to viz.

3 negative months	3 positive	3 negative	3 positive
December, January, February	March, April, May	June, July, August	Septbr., Octob., Novbr.

The temperature is consequently most equally distributed over the months in the equatorial regions, an effect of the relation to the sun, which is visible in observed

series of temperature by the smallness of the thermal distance from month to month, and consequently also by the numerical value of the coefficient MV, which decreases towards the Equator.

It is further of interest to observe the number of positive and negative months; these are not distributed in equal parts of 6 months each as is the case in the normal order in the temperate and polar Zones, but in the Tropes the number varies between 7 and 5 in the following manner:

North. Hemisph. ..	Tropic to 17° 30′	15° to 10°	7° 30′ to 5°	2° 30′
	6 positive	7 positive	6 positive	5 positive
	6 negative	5 negative	6 negative	7 negative
The Equator	6 positive			
	6 negative			

South. Hemisph. ..	Tropic to 17° 30′	15° to 10°	7° 30′	5°	2° 30′
	6 positive	7 positive	6 positive	7 positive	5 positive
	6 negative	5 negative	6 negative	5 negative	7 negative

If, therefore, any observed tropical series is found to consist of 7 or 5 positive months, i. e. of temperature $> M$ or v. v., this may be in perfect accordance with the effect of the cosmical factors in force over the particular latitude, whilst in the temperate and polar Zones the cause of a similar irregularity is always of a local nature.

An inspection of the thermal order of the months in vertical direction reveals the fact, that the winter-months north as well as south of Equator maintain their position in the series for a far greater number of degrees of latitude than the summer-months, which often change their position from parallel to parallel; thus January and July is the 12th month in the thermal order from the Tropics to respectively Equator and 2° 30′ South, February and August the 11th month to 2° 30′ N. and S. and so on, whilst July already in lat. 20° N. is replaced as number 1 by August, and this month in turn, in lat. 17° 30′ N., by June; July becomes already a negative month in the lat. 7° 30′ N., and takes the position as the 12th month in the lat. 2° 30′ S., maintaining this position throughout the rest of the southern latitudes. January is likewise in the lat. 20° S. replaced by December, this month in 15° S. by March and so on. The comparatively slow change in the position of the negative months involves a certain steadiness in the movement of temperature, provided the same is not disturbed by local powers.

The remarks in the preceding §§ 49—53 give a general view of the leading points in the present researches particularly concerning the tropical Zone; in the following, the comparison of actually observed to normal series of temperature will further the attempts to complete the analysis of any series of observed temperature.

54. The difference of the actually observed and the calculated normal temperature of each month has, according to the above given formulæ and definitions, been determined for a total of 137 places, of which 46 in the Northern polar and temperate Zone (Tab. XI), 57 in the tropical Zone (Tab. XII) and 34 in the Southern temperate Zone (Tab. XIII).

Classification of the term $\Sigma(\pm \Delta_m)$, the total difference of the observed and the normal series of temperature.

The tables give besides for each place the geographical position, the period of observations, the thermo-geographical coefficient MV, the total thermal displacement of the months, the mean yearly temperature and the sum $= \Sigma(\pm \Delta_m)$ of the difference of the observed and the normal series.

Tab. XI–XIII.

The places are arranged according to latitude and for the sake of reference enumerated and provided with the corresponding number of the place in Tab. IX and XV respectively.

The places in Tab. XII (the tropical Zone) are selected amongst those situated as near as possible the parallels specified in Tab. X; in the table the directing parallel is referred to, and thus the corresponding series of coefficients from Tab. X stated*).

The title-page of each table has been used for a classification in respect to the term $\Sigma(\pm \Delta_m)$ of the places named in the table. For this purpose the term $\Sigma(\pm \Delta_m)$ has been divided into 6 classes or groups, namely:

I	from 0	to 2,00 °C	and IV	from 6,00	to 9,00 °C
II	— 2,00	to 4,00	V	— 9,00	to 12,00
III	— 4,00	to 6,00	VI	over 12,00	

Together with the value of $\Sigma(\pm \Delta_m)$, the value of the coefficient MV is in this classification given for each place.

55. On account of the distribution of the places over the globe, the analyzed series of temperature, although not very numerous, are sufficient in variety to satisfy the definition of the series of differences $(\pm \Delta_m)$ as *the meteorological series*, representing the thermal action of the more or less irregular meteorological elements, such as the motion and other phenomena in the atmosphere and oceans or large inland lakes, influencing the temperature of the place in question.

The meteorological series.

Consequently the means, now given to ascertain, as exactly as observations admit, the numerical value of the term $\pm \Delta_m$, open a prospect to determine analytically the thermal effect of any of the meteorological elements.

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*) It will not escape attention, that the coefficients employed in Tab. XII only are exact, where the lat. of the place is the same as the lat. of the directing parallel. At this stadium the insignificant error caused by the above approximation may be overlooked, but in local and quite stringent investigations the exact numericals of course require to be determined as shown in § 52.

At present, however, we must content ourselves by dealing with and discussing the following relations:

$$M = \frac{\Sigma\,(t_m)}{12} \text{ and } M' = \frac{\Sigma\,(t'_m)}{12}$$

and consequently

$$\Sigma\,(\pm\,\Delta_m) = (t_1 - t'_1) + (t_2 - t'_2) + (t_3 - t'_3) + \ldots (t_{12} - t'_{12})$$
$$= \Delta_1 + \Delta_2 + \Delta_3 + \ldots \Delta_{12} = 0;$$

from these it follows*), that any meteorological element, contributing a constant surplus or depression of temperature, may be transferred to the year, and through the formulæ proportionately distributed to the months. Any *permanent* current acting in the same sense or direction the year round, as for inst. the Gulf stream, the trade-winds &c., are consequently only represented in the meteorological series by variations in the effect of the same, while the mean effect of such currents is visible in the yearly (raised or lowered) temperature, that is, in the thermo-geographical component of the same.

Permanently acting factors being by this modification excluded from the term $\pm\,\Delta_m$, it further follows, that the series of the same naturally divide themselves into two distinct groups, namely one representing the *periodically* and another the *irregularly* acting elements. The first class of groups appears particularly in the tropical series, and then the differences generally form two continuous series of positive and negative terms, while the second class, or the irregular groups of Δ_m, for the most part is found in the temperate zones, in which the + and — terms follow each other in apparently no distinct order.

As a rule the differences are in respect to number equally spread over the months, and therefore the *mean* monthly difference generally amounts to only 1—6th part of the total. This observation, when applied to the classifications in respect to the term $\Sigma\,(\pm\,\Delta_m)$, shows at once, that the meteorological elements as a rule only in extreme northern latitudes and in certain tropical regions appear to exercise a more marked power regularly to affect the solar potency.

Relations of the coeff. MV to different Zones, the function Q_m and the term $\Sigma\,(\pm\,\Delta_m)$.

56. The introduction in the analytical investigations of the term $\pm\,\Delta_m$ conveys a more distinct definition of the thermo-geographical coefficient MV. According to Tab. IX and the special researches, part III, the coefficient is found for the same place only to vary to a small extent and quite in conformity with an annual function. In the present

*) In the tables the sum of the positive and negative terms are in places not exactly alike, owing to the limited number of decimals employed; in case of any slight difference the total of the positive terms has been recorded.

researches the coefficient *MV* is found fully to answer this precise definition. The tables produced show further, that in the Southern temperate Zone the numerical value of *MV* reaches its max. in central and inland Australia with the moderate amount of 5,66 °C (Tab. XV, 335—351—376, Alice Springs—Thergomindal—Bourke); in the tropical zone the coefficients are of still smaller numerical value, and varies between 0,22 °C—0,24 and 3,98—4,74 (Tab. XV, 290—292 a, 327—231, Padang—Palembang, Tucuman—Hongkong). — The combined effect of the cosmical factors, the terrestrial positions, and, more especially, the effect of the Oceans, the narrow dimensions and the configuration of the Southern continents are most comprehensively illustrated by the above and intervenient figures, which indeed are remarkably small as compared to the coefficients *MV* from the broad continents in the northern temperate and polar Zones.

The coefficient *MV* augments or decreases at a uniform rate the normal movement in temperature, determined by the cosmical factors, and the term $\pm \Delta_m$ represents exclusively the effect of the meteorological anomalies acting differently in the different months, but consequently only so far as they do not neutralize each other during the month. — This distinction between the coefficient *MV* and the term $\pm \Delta_m$ is fully confirmed by the entirely different movement of the two terms, as will be seen from some few examples extracted from the tables.

Tab. XI		*MV*	$\Sigma(\pm \Delta_m)$	*Tab. XII*		*MV*	$\Sigma(\pm \Delta_m)$
19.	Quebec	10,30 °C	2,70 °C	3.	Mascat	3,94 °C	7,36 °C
38.	Fort Franklin	13,55	5,15	13.	Barbadoes	0,55	0,78
39.	Godthaab	5,27	4,73	18.	Bangalore	1,70	10,11
46.	Berings Island	4,09	9,05	29.	Lado	1,39	15,06

Tab. XIII

4.	Brisbane	3,32	2,24
9.	Pietermaritzburg	2,75	6,08
18.	Cape Town	2,63	1,09
20.	Buenos Ayres	4,30	2,75

From these and many other examples it is evident, that the local, additional term $\pm \Delta_m$, showing the distribution of the annual term $\Sigma(\pm \Delta_m)$, is not a simple function of the coefficient *MV*, but in the capacity as the *meteorological component* forms a distinct feature of the observed series of temperature.

Special researches on the term $\Sigma(\pm \Delta_m)$.

57. In order to facilitate more detailed investigations in respect to the term $\Sigma(\pm \Delta_m)$ the Author has prepared the Tab. XIV, in which the places are grouped according to the geographical situation in the 5 continents and in the Atlantic, the Pacific and Indian Ocean.

On the title-page is, besides, in a still more condensed form given a summary of the principal contents and data of the Tab. XI—XIII.

Tab. XIV.

If now the series of observed temperature as well as the numerical coefficient $MV \frac{6\ Q_m}{\Sigma(+\ Q_m)}$ be taken as exact, then a general prospect of the gradual deviation from the normal climate and the proportionately growing influence of the meteorological elements may be easily gathered from the collection of geographical and thermal positions classified in Tab. XIV, all due reservation being taken on account of the limited number of analyzed series of temperature*).

The 6 classes of the term $\Sigma(\pm\ \Delta_m)$ and the corresponding places are chiefly distributed as follows:

Class I, $\Sigma(\pm\ \Delta_m) = 0$ to $2{,}00$ °C.
This class, representing the almost pure normal climate, seems principally to be found in the *West-Indies* and adjacent places on the *Caraibian coast,* at the *Pacific coast of South-America,* the *Southern coast of Africa* (Cape Colony) and in the *Strait of Malacca.* Including some isolated places, this class together with

Class II and III, $2{,}00$ to $4{,}00$ and $4{,}00$ to $6{,}00$ °C
comprise 100 out of the total of 137 places, making for the three first groups respectively 17—50 and 33 places. Out of these numbers the places in *North- and South-America* are in the proportion of 19 to 7 divided between Class II and III, whilst in the parallel continents *Europe and Africa* class III is dominating, and the places divided in proportion of 10 to 13; in the 3rd group, *Asia and Australia,* a different and characteristic distribution takes place. In *Asia,* reaching from the polar to the tropical Zone and exposing the most extreme values of the coefficient *MV,* the class II is apparently quite excluded and class III only represented by a limited number of places in *India* and the *East-Indian Archipelago,* while in *Australia,* in the interior as well as round the coast, the class II is even more prominent than in North-America, and places of class III rather scarce.

In respect to places in the Oceans, it is to be remarked, that all the places in the *Pacific* and *Indian* Ocean belong to class II, but scarcely one (doubtful) to class I, and none to class III or extreme classes. Of the *Atlantic* places, the most southerly station at the coast of West-Greenland (Julianehaab) and Thorshavn belong to class II, and the rest, the polar stations excepted, to class III or near the same.

Class IV, $6{,}00$ to $9{,}00$ °C.
This class comprises chiefly some inland stations in *South-America* and *South-Africa;* in *Europe* some inland and northerly places, incl. two polar stations within reach of

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*) The series of temperature given in Tab. XI are for the greater part taken from Tab. IX, and the normal series composed of the calculated series in this table, the difference of the observed and the calculated mean yearly temperature being added to each month. It would be an easy task in this manner to add a considerable number of analyzed series of temperature to Tab. XI, but the number, given as examples, seems to answer the present purposes.

the Gulf-stream; in *Asia,* the East-Indian Archipelago included, this class is apparently as dominating, as class II in *North- and South-America* and *Australia.*

Class V and VI, 9,00 to 12,00 and over 12,00 °C
are represented in the extreme regions, in which, as already observed, the meteorological elements have the power in a sensible degree to modify the normal temperature. These regions include the *polar* and some *northerly* and *continental* places in *America, Greenland* and *Asia* together with places in the *tropical Africa* and *Asia.*

The above survey confirms once more in a decisive manner the early observation on the uniformity of the climate of (North-)America, that is, the preponderance of the cosmical factors (Q_m), or rather the less influence of meteorological (disturbing) elements, present in this continent, as compared with Europe-Asia, but the remark may now for the same reasons, and anew numerically fortified by the meteorological component, be extended to the entire Southern Hemisphere.

It follows further from the above detailed researches and from the résumé added to Tab. XIV, that for by far the greatest part of all places the mean deviation from the normal monthly temperature may be calculated not to exceed $\pm 1^0$ C, or less, and that the mean difference only in certain extreme regions and in situations of high continentality may be expected to exceed the above moderate quantity. But even the extreme of the specified mean differences do not reach the amount of oscillations, observed in actual measurements of temperature (§ 34); the position of the normal, calculated series of temperature as compared to actual observations remains therefore as defined in § 37, but with the exception of certain tropical series exposed to the effect of periodically and regularly acting meteorological elements, not yet included in the formulæ.

58. In continuation of the special researches, the annexed table, containing a diagram of the Monsoon districts of India, has been prepared in order to provide the moments for a further discussion of details of several of the extreme meteorological components.

Continued researches on the meteorological series. Continuous and irregular series. The Monsoon districts of India.

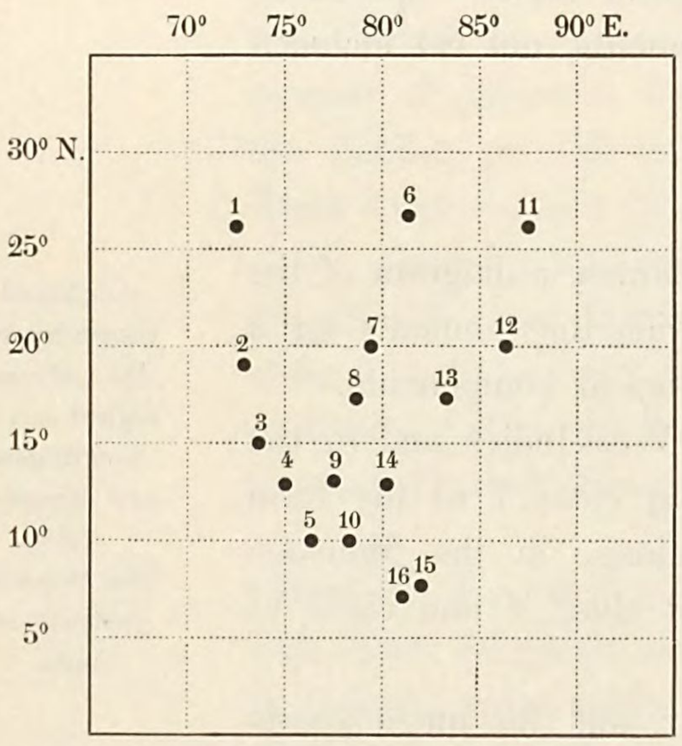
The places, named in this table, are situated in the West-Indies and in the East-Indian Archipelago and selected as specimens representing class I of the term $\Sigma(\pm \Delta_m)$; several places situated in northern and polar regions, in the Monsoon districts of India and in the interior of tropical Africa represent class V and class VI and a few of lower order.

The series are all classified as *continuous* or *irregular,* and the mean yearly temperature, the coefficient MV and the total displacement given for each place, together with the usual geographical data.

In respect to the classification in continuous and irregular series it should here be observed, that in the Authors opinion the principal difference of both is not to be sought exclusively in the regularity of the distribution of the positive and negative

DIAGRAM AND TABLE OF PLACES

Situation	Nr. in diag.	Place	lat.	long.	Height	mean yearly temp. °/F	*MV* °/F	total displacement	$\Sigma(\pm \Delta_m)$ °/F	Series $\pm \Delta_m$
				$\Sigma(\pm \Delta_m) = 0$ *to* $2{,}00$ °C						
The West-Indies	-	Havana	23° 8′ N.	82° 3′ W.	19	78,43	3,687	4	± 2,89	irregul.
The West-Indies	-	Barbadoes	13° 4′ N.	59° 40′ W.	8	80,78	0,993	8	1,40	irregul.
The East-Indian Archipelago	-	Palembang	2° 50′ S.	104° 53′ E.	6	80,38	0,437	28	2,07	irregul.
				$\Sigma(\pm \Delta_m) = 9{,}00$ *to* $12{,}00$ °C *and over* $12{,}00$ °C						
Polar Region: North of Greenland	-	Fort Conger	81° 44′ N.	64° 45′ W.	0	— 4,13	25,58	6	±30,23	irregul.
Polar Region: West-Coast of Greenland	-	Upernivik	72° 47′ N.	55° 53′ W.	12	17,74	15,62	6	27,47	contin.
Polar Region: West-Coast of Greenland	-	Jacobshavn	69° 13′ N.	50° 55′ W.	13	23,25	13,70	4	16,19	irregul.
Berings-Sea	-	St. Michaels	63° 48′ N.	161° 0′ W.	10	26,92	16,56	4	18,05	contin.
Berings-Sea	-	Berings Island	55° 12′ N.	165° 55′ E.	6	35.76	7,54	14	16,30	irregul. (?)
Polar Region of Siberia	-	Werchojansk	67° 34′ N.	133° 51′ E.	140	— 0,89	38,90	6	32,49	contin.
Eastern Siberia	-	Olekminsk	60° 22′ N.	120° 26′ E.	122	18,86	30,69	6	26,09	contin.
				West of India and the Peninsula						
Diagram showing position of places in the Monsoon districts of India.	1	Pachpadra	25° 55′ N.	72° 18′ E.	116	77,80	10,083	20	±24,40	irregul. (?)
	2	Bombay	18° 54′ N.	72° 49′ E.	11	79,37	2,385	20	9,28	irregul,
	3	Goa	15° 21′ N.	73° 56′ E.	7	81,83	1,770	54	15,94	contin.
	4	Mangalore	12° 52′ N.	74° 54′ E.	16	78,62	1,823	44	14,51	contin.
	5	Cochin	9° 58′ N.	76° 17′ E.	4	79,63	1,647	58	14,75	contin.
				Middle of India and the Peninsula						
	6	Lucknow	26° 50′ N.	81° 0′ E.	113	78,24	9,720	22	±27.40	contin.
	7	Chanda	19° 56′ N.	79° 19′ E.	199	78,83	6,482	34	34,77	contin.
	8	Secunderabad	17° 27′ N.	78° 33′ E.	545	77,77	4,820	36	29,94	contin.
	9	Bangalore	12° 59′ N.	77° 38′ E.	909	72,81	3,060	30	18,19	contin.
	10	Madura	9° 55′ N.	78° 10′ E.	137	81,88	2,790	28	10,65	irregul. (?)
				East of India and the Peninsula, Isle of Ceylon						
	11	Purneah	25° 50′ N.	87° 34′ E.	38	76,92	7,476	14	±16,88	irregul.
	12	Cuttack	20° 9′ N.	85° 55′ E.	24	80,71	5,053	28	20,54	contin.
	13	Visagapatam	17° 42′ N.	83° 22′ E.	10	82,73	3,627	22	10,56	contin.
	14	Madras	13° 4′ N.	80° 14′ E.	7	81,67	3,680	22	9,76	irregul. (?)
	15	Batticaloa	7° 43′ N.	81° 44′ E.	8	81,93	2,287	26	8,45	irregul.
	16	Kandy	7° 18′ N.	80° 40′ E.	517	76,38	1,280	32	7,30	contin.
Continental Africa, Sahara	-	Kouka	12° 52′ N.	13° 23′ E.	280	83,28	5,137	26	±23,94	contin.
Continental Africa. Sudan	-	Lado	5° 2′ N.	31° 50′ E.	465	79,98	2,500	62	27,11	contin.



WITH EXTREME VALUES OF $\Sigma\,(\pm\,\Delta_m)$.

January	February	March	April	May	June	July	August	Septbr.	October	November	December
− 0,05	− 0,55	+ 0,76	+ 0,04	+ 0,01	+ 0,34	− 0,68	− 0,55	+ 0,26	+ 0,62	+ 0,86	− 1,01
− 0,08	− 0,35	− 0,11	− 0,28	− 0,23	+ 0,12	+ 0,28	+ 0,30	− 0,45	− 0,03	+ 0,49	+ 0,21
− 0,18	− 0,19	+ 0,06	− 0,65	+ 0,56	+ 0,32	+ 0,33	+ 0,10	+ 0,70	− 0,24	− 0,35	− 0,41
+ 8,96	− 3,94	+ 2,70	− 5,76	+ 2,21	+ 4,77	+ 1,15	+ 1,93	− 5,22	− 8,77	− 6,55	+ 8,51
+ 2,68	− 6,48	− 8,77	− 5,71	− 2,99	− 1,96	− 1,17	− 0,38	+ 2,11	+ 3,96	+ 9,49	+ 9,23
+ 3,11	− 4,57	− 6,71	− 2,95	− 0,97	+ 0,34	+ 1,13	+ 0,29	− 0,40	− 0,59	+ 4,14	+ 7,18
+ 5,92	− 4,21	− 4,37	− 4,63	− 3,38	− 1,53	+ 1,60	+ 2,20	+ 2,12	+ 1,19	+ 1,73	+ 3,29
+ 3,10	+ 2,25	− 1,21	− 5,33	− 4,93	− 3,31	− 0,81	+ 4,52	+ 4,00	+ 0,50	− 0,85	+ 1,93
+ 3,94	+ 1,66	+ 6,95	+ 9,14	+ 6,64	+ 4,16	− 0,54	− 5,76	− 2,21	− 7,15	−14,26	− 2,65
− 1,15	+ 3,29	+11,14	+ 6,21	+ 2,43	+ 2,66	+ 0,36	− 4,23	− 2,70	− 1,33	− 8,93	− 7,65
− 0,84	− 0,55	+ 5,90	+ 8,71	+ 7,30	+ 2,02	− 5,86	− 8,75	− 2,78	+ 0,47	− 3,08	− 2,53
− 1,66	− 1,02	+ 1,86	+ 2,94	+ 3,00	+ 0,29	− 1,53	− 2,59	− 2,36	+ 0,45	+ 0,74	− 0,17
+ 0,65	+ 2,26	+ 2,98	+ 3,03	+ 2,33	− 1,58	− 3,23	− 4,23	− 5,02	− 1,94	+ 1,96	+ 2,73
+ 1,19	+ 1,70	+ 3,97	+ 4,16	+ 1,50	− 2,26	− 2,81	− 3,15	− 4,32	− 2,01	+ 0,85	+ 1,14
+ 2,22	+ 2,99	+ 4,21	+ 3,42	− 0,57	− 2,54	− 2,78	− 2,72	− 3,72	− 2,38	+ 0,36	+ 1,55
− 1,68	+ 1,12	+ 7,62	+10,23	+ 6,80	+ 1,63	− 6,94	− 6,67	− 2,69	− 1,40	− 3,65	− 4,45
+ 0,14	+ 4,11	+ 9,46	+11,54	+ 9,52	− 1,14	− 6,91	− 8,17	− 6,13	− 3,45	− 4,73	− 4,20
+ 0,31	+ 4,58	+ 8,82	+ 9,51	+ 6,72	− 2,59	− 5,49	− 6,25	− 7,18	− 3,26	− 3,01	− 2,21
+ 0,04	+ 3,38	+ 6,66	+ 6,58	+ 1,53	− 1,69	− 2,27	− 2,94	− 5,44	− 3,01	− 1,65	− 1,22
+ 0,56	+ 1,42	+ 3,19	+ 2,54	− 1,09	+ 0,90	+ 1,86	+ 0,18	− 0,69	− 3,71	− 2,18	− 0,95
− 2,27	− 0,10	+ 6,07	+ 7,90	+ 1,66	− 1,47	− 4,46	− 3,56	− 0,50	+ 1,25	− 1,04	− 3,53
− 1,65	+ 2,10	+ 7,04	+ 7,29	+ 4,11	− 1,53	− 3,81	− 4,56	− 2,75	− 0,44	− 2,44	− 3,98
− 0,85	+ 1,08	+ 3,95	+ 3,71	+ 1,82	− 0,16	− 1,23	− 1,70	− 2,33	− 0,55	− 1,21	− 2,59
+ 0,91	− 0,09	+ 2,84	+ 2,08	+ 0,52	+ 1,82	+ 1,54	+ 0,05	− 3,61	− 3,28	− 2,22	− 0,61
+ 0,81	+ 0,56	+ 0,91	− 0,25	− 1,23	+ 1,82	+ 2,86	+ 1,49	− 1,34	− 3,30	− 1,98	− 0,32
+ 0,37	+ 1,67	+ 3,24	+ 1,65	+ 0,34	− 0,63	− 0,63	− 0,85	− 2,06	− 2,31	− 0,78	+ 0,03
+ 1,44	+ 2,70	+10,10	+ 7,83	+ 0,73	+ 1,14	− 2,26	− 7,62	− 8,88	− 1,74	− 1,33	− 2,08
+ 7,56	+ 9,08	+ 6,38	− 1,83	− 4,39	− 3,09	− 2,05	− 2,94	− 5,37	− 6,39	− 1,12	+ 4,09

terms of the series now presented, but more in the circumstance, that, in series from different consecutive years or periods, the monthly differences in strictly irregular series most probably will exhibit a tendency to neutralize each other, and the resultant of all oscillations to become = 0, while in continuous series, if they really represent the thermal effect of regularly acting phenomena, the arrangement of the positive and negative terms naturally remains unaltered from year to year. As a consequence, minor deviations from the regular order may probably be accepted as a sign of the proximity of the place to that particular meteorological phenomenon, which in neighbouring places produces a pure continuous series*).

Considering now class I, represented by the series of Havana, Barbadoes and Palembang, and in the complete tables by series of several already mentioned places, the same indicates of course a remarkably close approximation of the normal to the observed series of temperature, the difference of both being for most of the months next to null, and for many of them less than $^1/_2$ °C, or a fraction thereof. The conclusion is, that the disturbances of the normal movement in the temperature, caused by meteorological phenomena, are in these places either of very little consequence, or, if momentary more influential, that an almost perfect neutralization occurs within each month.

Local investigations are required to demonstrate the correctness of the above considerations, more especially on account of the very small quantities, which are to be dealt with.

The triangular configuration of the Indian Peninsula, the uniformity in the physical construction and the position of the same in respect to the periodical Monsoons render this vast country a most suitable object for researches in respect to thermo-geographical factors and terms.

Following the arrangement and the diagram on the preceding table, we give, therefore, on the next page a résumé of the Indian part of the same, showing the coefficient *MV* and the distribution of the positive and negative terms of the meteorological component for the Indian and, for comparison, for several other places, producing continuous series of the higher class.

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*) This definition gives no doubt the true meaning of the insignificant irregularities observed in the series of *Madura* (10) and *Madras* (14), and it is in this case rendered the more plausible by the moderate value of the term $\Sigma(\pm \Delta_m)$, amounting to respectively $10{,}_{65}$ and $9{,}_{75}$ °F.

	lat.	MV,°/F	$\Sigma(\pm \Delta_m)$, °/F	*positive terms*		*negative terms*	
Upernivik ..	72° 47′ N	15,62	27,47	September—January	(5)	February—August	(7)
St. Michaels ..	63° 48′	16,56	18,05	July —January	(7)	February—June	(5)
Werchojansk	67° 34′	38,90	32,49	January —June	(6)	July —December	(6)
Olekminsk ..	60° 22′	30,69	26,09	February —July	(6)	August —January	(6)
Goa	15° 21′	1,77	15,94	November—May	(7)	June —October	(5)
Mangalore ..	12° 52′	1,82	14,51	November—May	(7)	June —October	(5)
Cochin	9° 58′	1,65	14,75	November—April	(6)	May —October	(6)
Lucknow ..	26° 50′	9,72	27,40	February —June	(5)	July —January	(7)
Chanda	19° 56′	6,48	34,77	January —May	(5)	June —December	(7)
Secunderabad	17° 27′	4,82	29,94	January —May	(5)	June —December	(7)
Bangalore ..	12° 59′	3,06	18,19	January —May	(5)	June —December	(7)
Cuttack	20° 9′	5,05	20,54	February —May	(4)	June —January	(8)
Visagapatam	17° 42′	3,63	10,56	February —May	(4)	June —January	(8)
Kandy	7° 18′	1,28	7,30	December —May	(6)	June —November	(6)
Kouka	12° 52′	5,14	23,94	January —June	(6)	July —December	(6)
Lado	5° 2′	2,50	27,11	December —March	(4)	April —November	(8)

This scheme shows at once, that within the Indian boundary, and as far as the same is represented by the registered places, it is one and the same phenomenon, which raises the mean monthly temperature over the normal line in about 6 distinct and consecutive months of the year and causes a corresponding depression of the same in the remaining months. The positive period seems to begin earlier (November) at the west-coast than in the middle and at the eastern coast (January—February), but to end more regularly all over in about the month of May. The negative period begins therefore as a rule in the month of June, but seems to end earlier at the west-coast (October), and later (December—January) in the middle and at the eastern coast.

The above periods answer broadly to the periods of the Monsoons, S.W. April—October, N.E. November—March; the nearest approximation seems to appear at the west-coast, where the positive period and the N.E. Monsoon, the negative period and the S.W. Monsoon almost coincide.

The thermal influence of the Monsoon do of course not only depend on the temperature, direction and force of the same, but also on the thermal position of the place considered. In places with a low coefficient MV*), which reduces the effect of

*) The coefficient MV has been so fully discussed in part III and V, and the quality of the same as a function of the distance from the oceans or great lakes demonstrated by special researches (part V), that further reflections on this factor may now be dispensed with. — That the definition of the coefficient MV holds good in tropical zones appears from Tab. XII and XV, and as far as India is

the dynamo-cosmical functions to a minimum, a greater margin will be left for meteorological forces to mark and alter the normal series; the successive displacement of the (normally) warmest month and generally the successive defiguration (according to latitude) of the curve of temperature are moments, which enter the considerations on the continuous series.

The generally low value of the term Δ_m in the transit from the positive to the negative period, and v. v., and the position of max. in about the middle of each give, in connection with the successive rise and fall of the meteorological components, to the continuous series that undulating motion, which is perceptible in all natural phenomena, subjected to a distinct law.

The maxima and limits of continuous series may serve as means to ascertain the position of the centre and the boundaries of the periodical disturbances of the normal conditions, and thus to add a most valuable moment to the thermo-geographical structure of the country. In India *Chanda* seems to be situated near such a centre, in which the thermal effect of the Monsoon reaches its max. and from which it descends in all directions.

Most of the above reflections apply to the continuous series of *Werchojansk* and *Olekminsk* in North-Eastern Siberia and of *Kouka* and *Lado* in Sahara and Sudan, in which places even the periods are composed of almost the same months as the periods in the Indian Monsoon-districts. — The continuous series of *Upernivik* and *St. Michaels* are different from those of India, but the periods in each of the two places include about the same months; it remains for further investigations to confirm, whether this somewhat surprising simultaneity is founded upon the circumstance, that the places are exposed to remote branches respectively of the Gulf stream and Kuro Siwo stream (?), or if the periodicity in the series of such northerly places on the whole is questionable, or to be ascribed to unknown polar phenomena.

Further researches on continuous series.

59. The continuous series deserve special attention and are therefore marked „C“ in Tab. XIV; in the following prospect, the places producing continuous series, but not named in the preceding discussions, are grouped according to their geographical situation, isolated places are omitted and an irregular series (Assuncion) added for comparison.

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concerned, a reference to the tables and the résumé shows, that the regular decrease of the coeff. from *Lucknow* to *Madura,* or from, $9{,}_{720}$ °F to $2.{}_{790}$ °F in proportion to the decrease of the cross-sections of the Peninsula, is quite in accordance with the observations from northern continents and countries, part V, §§ 43—47.

		January						July					December	$\Sigma(\pm \Delta_m)$
North-America														
Tab. XI	23. New York	+	−	−	−	−	−	−	+	+	+	+	+	3,89 °C
	27. St. Louis	−	+	+	+	+	+	0	+	+	−	−	−	2,60
Central America and the West-Indies														
Tab. XII	7. Christiansted	+	−	−	−	−	−	+	+	+	+	+	+	1,51
	20. San José	+	+	+	+	−	−	−	−	−	−	−	−	5,98
	23. St. Ann's Trinidad	−	−	−	−	−	−	−	−	−	+	+	+	1,49
South-America														
Tab. XII	54. Salta	−	−	−	−	−	−	−	+	+	+	+	+	7,11
	55. Assuncion	+	−	−	−	−	−	+	+	+	+	+	−	6,03
Tab. XIII	1. Tucuman	−	−	−	−	−	−	−	+	+	+	+	−	6,84
Atlantic Ocean														
Tab. XI	30. Bermuda	+	+	−	−	−	−	0	+	+	+	+	+	7,35
Tab. XII	10. Praya	+	−	−	−	−	−	−	+	+	+	+	+	5,40
	40. Ascension	+	+	+	+	+	+	+	+	+	−	−	−	7,54
Eastern part of the Mediterranean														
Tab. XI	22. Constantinople	+	−	−	−	−	−	+	+	+	+	+	+	6,13
	28. Athens	+	−	−	−	−	−	+	+	+	+	+	+	4,03
	31. Jerusalem	−	−	−	−	−	−	−	−	+	+	+	+	5,42
West of Africa														
Tab. XII	28. Christiansborg	+	+	+	+	−	−	−	−	−	−	+	+	9,39
	34. St. Thomas	+	+	+	−	−	−	−	−	−	−	−	+	4,18

The quality of the difference offer many points for reflections, as for inst. the apparent majority of negative terms in the earlier part of the year and the change, which often seems to take place by the month of July; but such observations must here necessarily be abandoned.

With all precautions in respect to conclusions drawn from a comparatively small number of observations, it seems nevertheless now placed beyond doubt, that continuous series are not of a very frequent occurrence, and that such are mostly found in places on the Northern Hemisphere, and only sporadically South of Equator; Australia and New Zeeland for inst. offer only one, and not a particular good, specimen of continuous series.

The proportion of land to water and the broad oceans, covering by far the greater part of the Southern Hemisphere, reduce in a great measure the conditions for the formation of periodical winds and oceanic currents of greater intensity; it seems therefore but natural, that this physical state of the Southern Hemisphere in our researches has been proved by the absence of continuous and the prevalence of irregular series, causing the small average of the terms $\Sigma(\pm \Delta_m)$, which is prominent in Tab. XIV for all the places in southern latitudes.

The series of the *Mascaren Islands* in the *Indian Ocean,* given beneath, offer an example of the close resemblance in irregular series produced

Tab. XII	*MV*	January						July					December	$\Sigma(\pm \Delta_m)$
49. St. Denis, Réunion . .	1,82 °C	+0,19	−0,31	+0,70	+2,18	+1,19	−0,46	+0,47	−0,20	−0,25	−0,77	−1,09	−1,68	= 4,73 °F
40. Mauritius, R. O. . .	1,89	+1,01	−0,54	+0,33	+2,13	+1,64	+0,46	−0,08	−0,26	−0,67	−1,08	−1,22	−1,71	= 5,57
51. Rodriguez	1,86	+0,97	−0,46	+0,68	+2,33	+1,70	+0,40	+0,04	−0,53	−0,42	−1,19	−1,88	−1,64	= 6,12

by separated, but neighbouring places, exposed to the parallel action of oceanic and atmospherical influences. The coefficients *MV* for the 3 places being almost equal, and the domain of researches consequently confined to a minimum of factors, this isolated, insular system seems therefore to present a most interesting object for the study of the thermal, irregular series.

Analysis of a characteristic North-Atlantic series of temperature.

60. The examination and analysis of several series of temperature has disclosed some interesting relations between the formulæ employed and a certain class of observations, as for inst. some of those, which are specified in the Challenger Reports for positions in the North-Atlantic Ocean.

In view of the importance of this matter full particulars are here given relative to the position lat. 22° 30′ N. and long. 22° 30′ W. — For this latitude the numericals and signs of the coefficient $\frac{(6\ Q_m)}{\Sigma(+\ Q_m)}$ have been determined for each month as follows:

January	−1,5762	July	+1,5113
February	−1,3271	August	+1,4939
March	−0,9454	September	+0,9194
April	−0,1688	October	+0,1375
May	+0,6596	November	−0,6706
June	+1,2782	December	−1,3116

The coefficient *MV*, derived from the observed series of the position, is equal to 2,847 °F. From the original series of temperature and from these data we find now for the said position:

	January						July					December	the year
observed temp., °/F	70,3	69,7	69,8	71,5	72,4	74,8	76,9	77,8	78,4	77,6	75,7	73,3	74,02 °F
calcul., normal temp.	69,53	70,24	71,33	73,54	75,90	77,66	78,32	78,27	76,66	74,41	72,10	70,26	74,02
difference . . .	+0,77	−0,54	−1,53	−2,04	−3,50	−2,86	−1,42	−0,47	+1,74	+3,19	+3,60	+3,04	±12,34

Now it will be seen, that the calculated normal series throughout the year comes surprisingly near the observed temperature, if the calculated series be displaced one month; this operation gives namely the following series of temperature:

observed temp.	$70,_3$	$69,_7$	$69,_8$	$71,_5$	$72,_4$	$74,_8$	$76,_9$	$77,_8$	$78,_4$	$77,_6$	$75,_7$	$73,_3$	$74,_{02}$ °F
normal, displaced series . . .	$70,_{26}$	$69,_{53}$	$70,_{24}$	$71,_{33}$	$73,_{54}$	$75,_{90}$	$77,_{66}$	$78,_{32}$	$78,_{27}$	$76,_{66}$	$74,_{41}$	$72,_{10}$	$74,_{02}$
difference	$+0,_{04}$	$+0,_{17}$	$-0,_{44}$	$+0,_{17}$	$-1,_{14}$	$-1,_{10}$	$-0,_{76}$	$-0,_{52}$	$+0,_{13}$	$+0,_{94}$	$+1,_{29}$	$+1,_{20}$	$\pm 3,_{94}$

By the displacement the total difference of the observed and the calculated temperature has thus been reduced from $12,_{34}$ °F to $3,_{94}$ °F, or at an average to less than $1/_3$ of the original difference. At the same time the total displacement in respect to the thermal order of the months has been reduced from 28 to 8, and the originally strictly continuous series converted into a slightly modified one.

The above results, obtained by a simple process, deserve certainly the utmost attention, the more so, as the observation is not an isolated one; it must, however, here be noticed, that in the western part of the Ocean, lat. 22° 30′, long. 72° 30′ W., the experiment gives a reduction of much less magnitude, from $6,_{37}$ to $5,_{35}$ °F, and that the eventuality of an increase of the difference is by no means excluded.

It would, however, lead too far from the present researches to follow further this important subject. but the remark should here be made, that the analytical method now permits the proof of the *permanent* effect of deep oceans on the construction of normal series of temperature, just as in analogical researches the effect of the depth of the Caspian sea on the coefficient MV (part III, § 28); the numerical decision in both problems, and particularly the relation to the term of retardation in the fundamental formula (9) (§ 20) would no doubt prove advantageous in many geo-physical investigations.

General researches on the movement in temperature over the surface of the Globe.

Tab. XV.

61. In paragraph 54 the classification of the Months in respect to the thermal order has been defined, and the motives for the introduction of this mode of comparison of observed to the normal series of temperature stated. The ease, with which this mode of determining the deviation of any observed series of temperature from the normal series can be applied, and the informations, which in thermal researches can be derived from such comparisons, have induced the Author to prepare the Tab. XV, in which 407 series of temperature have been dealt with from this point of view.

The specified places in this table are all extracted from the Challenger Reports, and selected on the same principle as generally followed in these researches; the places represent therefore all quarters of the Globe as far as observations have been accessible, and the occasion is taken to give, besides the moments required for the special object, the geographical data, the period of observations, the coefficient MV etc., together with the term $\Sigma(\pm \Delta_m)$, when determined for the proper place. — All statements of temperature are in this table given in degrees Centigrade.

The places are arranged in the order from North to South and from West to East; the temperate and polar places of both hemispheres in zones of 5° lat., but the tropical places in latitudes corresponding as near as possible to the specified parallels of Tab. X.

On looking over the „total displacement“ (col. 8) the interesting fact will at once be observed, that the deviation from the normal order in both hemispheres gradually increases towards the Equator, in the region of which the total displacement of the Months reaches its maximum.

The cause of this phenomenon is almost entirely of „arithmetical“ nature, and lies in the fact, that the difference in temperature from month to month in the tropical zone, and particularly in the equatorial regions, is so extremely small, that it is an easy work for the meteorological elements, particularly those of permanent or periodical character, to disturb the normal order in this zone, while in the temperate and polar zones the thermal differences from natural causes are considerable, hence it is more difficile for the irregular thermal powers of second order to bridge over the distance.

The regularity in the movement of the total displacement calls for no more detailed classification, but a simple enumeration of the places producing *the least amount of displacement (0 and 2)* will be of interest. The list comprises in the order of the table the following places.

NORTHERN HEMISPHERE, *temperate and polar zone,* 65 out of 223 places.

2	Fort Hope	(66°32′)	61	Medicine Hat	121	Marseilles	
7	Bodö	67°17′	62	Moose Factory	124	Rome	
11	Obdorsk	66°31′	68	Dublin	125	Pola	
14	Ssredne-Kolymsk	67°10′	69	London-Greenwich	126	Naples	
17	Fort Franklin		70	Amsterdam	131	P. Alexandrowsky	
21	Ivigtut		71	Hamburg	132	Krassnowodsk	
23	Stykkisholm		72	Berlin	143	St. Louis	
28	Bergen		73	Warsaw	144	Washington	
29	Christiansund		74	Kursk	145	Cape Hatteras	
30	Østersund		77	Barnaul	159	Athens	
32	Åbo		80	Nicolajewsk	160	Smyrna	
35	Archangel		82	Petropaulowsk	162	Eriwan	
36	Usk-Syssolsk		83	Victoria	167	Pekin	
42	Sitka		84	Olympia	180	Charleston	
43	York Factory		86	Montreal	181	North Atlantic	
44	North Atlantic		87	Quebec	192	Suez	
46	North Atlantic		88	Anticosti, W.P.	198	Hankow	
48	Christiania		101	Astrakhan	199	Shanghai	
49	Copenhagen		110	Omaha	203	Punta Rassa	26° 9′
50	Stockholm		111	Chicago	206	North Atlantic	27°30′
51	St. Petersburg		112	New York	219	Darjeeling	27° 3′
59	Ilinlink Harbour		113	M. Washington	220	Kiukiang	29°44′

TROPICAL ZONE, 115 places . . . . 231 Hong Kong 22° 18′ N.

SOUTHERN HEMISPHERE, *temperate zone*, 16 out of 69 places.

336	Moreton Bay	27° 1′	370	East London	381	Quinquina	
344	Springbok	29°40′	371	Bunbury	393	Napier	
355	Valparaiso		374	Adelaide	402	Queenstown	45° 2′
362	Monte Video		379	Corral	403	Christchurch	43°32′
364	Cape Town		380	Valdivia	404	Nelson	41°16′
369	Port Elisabeth						

Of places in extreme geographical positions and with a moderate amount of displacement may be named

Northern Hemisphere.

3	Fort Conger, the northmost place on record, 8° 16′ from the Pole, total displ. = 6		200	Nagasaki (4)	
4	Upernivik (6)	72° 47′	214	Bushire (4)	
5	Jacobshavn (4)	69° 13′	222	Kelung (4)	
12	Sagastyr (6)	73° 23′	223	Havana (4)	
	Most of the West-Greenland and Icelandic stations, and numerous places to		229	Mascat (10)	
			236	Djedda (12)	
			241	Christiansted (12)	
193	Jerusalem (4)		253	Barbadoes (8)	
194	Bagdad (4)		260	Aden (12)	12° 45′
			268	Caraccas (14)	10° 30′

Southern Hemisphere.

303	Banjoewangi (14)	lat. 8° 17′	333	Pretoria (6)	
305	St. Paul de Loando (14)	8° 49′	338	Serena (4)	
309	Bahia (14)	12° 58′	354	Brisbane (4)	lat. 27° 28′
313	Sweers Island (14)	15° 0′		and numerous places to	
315	Delanasau (10)	16° 38′	396	Ushaja, the southmost place on record (4)	lat. 54° 53′
317	Iquique (6)				
323	Ravenswood (6)				

From these examinations, followed by an attentive survey of Tab. XV, it may be concluded,

that the normal order in series of observed temperature has been maintained in a great number of places representing all latitudes of the entire temperate zones,

that for the rest, and even in extreme polar regions, only inconsiderable disarrangements in the thermal order seems to be the rule, and

that displacements of importance are restricted to the tropical zone, and particularly to a region extending to about 10^0 lat. on either side of the Equator, and to the Monsoon-districts.

Of the fundamental quantities entering the formulæ it is principally the term representing the retardation (§ 20), which determines the normal order in series of temperature. The above researches and conclusions confirm therefore the correct working of the analytical expression of this interesting factor.

Remarks concerning changes in the present fundamental conditions of temperature.

62. In a twofold manner the normal series of temperature may then prove useful for meteorological investigations. — The series, being founded upon a uniform formula composed of factors of proved stability and generalized so as to comprise the different zones with the same degree of correctness, have in numerous applications shown themselves to be numerically in concord with nature, and to offer the means required for further analysis of the meteorological series, i. e. the effect of the proper thermo-geographical system of the position considered.

Passing over the renewed verification of the fundamental terms of the formulæ thus obtained, the occasion is taken to lay stress upon the fact, that the principal point in the plan of the present studies: the distinguishment made in the formulæ for the year as well as for the months between fundamental functions in force over the whole surface of the globe, and those of absolute geographical and limited nature, makes it possible to introduce partial corrections without being compelled to re-construct numerically the whole system. From this point of view it is of interest to notice, that several Authors anticipate certain calamities, imagining the same to originate either in changes in universal powers or in the present thermo-geographical conditions, in either case threatening with total or partial catastrophes. In the last case the scene of the dreaded event is generally transferred to the Atlantic Ocean and especially to the Gulf stream, but without any exposition of the compensations, which in the Authors opinion naturally and simultaneously would follow the development of a purely terrestrial phenomenon. Without on this occasion to express any opinion on the probability of one or another of the above hypotheses, the Author observes here, that in nearly all the specified sections the partial system of equations of temperature are influenced by the Atlantic Ocean and the Gulf stream. An organization of control-observations would therefore, if referred to an analytical fundation, by combinations and in course of time enable to trace any of the above changes, and to mark the special function affected by the same, i. e. to ascertain the extent and cause of the observed phenomena, temporary disturbances included. — Practical plans might probably result from an attentive service of control, organized for watching the thermal effect of the Atlantic Ocean and the Gulf stream, and these expectations appear still more attainable for the reason, that the present researches in no instance have disclosed any discrepancy, which could not in every way be explained by the existing thermal system, and, when fully investigated, brought within the grasp of the thermo-geographical analysis and formulæ.

63. The general result of the completed work may be expressed in the conclusions, Conclusions.

that the codified system of thermo-geographical formulæ, included corrections for certain extreme regions, produces results approximately equal to means of many years of actual observations, and

that the same opens a new field for analytical investigations in the physical geography, based upon the temperature as the standard-unit for the measurement and comparison of geo-physical and meteorological elements.

VII.

ADDITIONAL STUDIES ON THE TEMPERATURE OF PLACES IN THE ARCTIC ZONE. (1896).

Introductory remarks.

64. The arctic regions afford a most attractive object for analytical investigations of temperature; actual observations are, as a consequence of the natural conditions, either not obtainable or scarce and incomplete, and at any rate limited to short periods and spread over immense areas. An attempt to enter the thermal part of the arctic mysteries is therefore, if successful, as interesting as promissory for the further development and application of analytical researches. — The question of arctic temperature is just at this moment emphasized by the successful Polar-Expedition of Dr. Fridtjof Nansen, whose observations in hitherto unexplored fields may be expected to present many points of comparison to the analytical methods and results, whilst it has its own interest to use the occasion to publish the latter *before* the authentic records of the expedition are in the hands of the large circle of scientific societies and persons, interested in arctic explorations.

The special arctic researches comprise the Northern Atlantic and Polar Ocean, including shores and islands situated between Greenland and Norway, and in the polar region limited by the meridians 90° W. and E.; the North Pole and the Parallel of 60° form the limit in respect to latitude, and the Danish north-atlantic colonies and adjacent places the meteorological basis of the territory, treated in this part of the studies.

It has already been stated (§ 17), that for extreme parts of the polar zone a correction must be applied to the mean yearly temperature, when derived from the general formulæ; this correction has been effected through the annual thermo-geographical component $(t_{\varphi, \lambda})$, and an improved table for determining the mean yearly temperature of arctic positions has thus been obtained. — In the present additional studies a method for the completion of interrupted observations of temperature has further on been exposed, and also a method, with which the thermo-geographical coefficient *(MV)* may be determined in analogy with the result of the special researches on the movement of this function, when traversing extensive continents, §§ 44 and 45.

The sketch, given on page 116, represents that part of the North Atlantic and Polar Ocean, dealt with in these paragraphs; the same shows, besides other moments, the situation of the places, named in the tables adjoined the sketch (page 117); a convenient survey of the matters referred to in the present special researches has thus been obtained.

Formation of a special arctic table of temperature

65. While the geographical component $t_{\varphi,\ \lambda}$ — expressing the thermal deviations from the normal temperature along a parallel-circle — according to the special researches may be determined with quite acceptable correctness up to the latitude of 65—70°, continued considerations give at hand, that for more northerly latitudes the thermo-geographical component decreases more rapidly than would follow from the general formulæ, and that, therefore, in extreme high latitudes the mean yearly temperature at the different points of the same approximates more and more the calculated normal temperature of the parallel; at the North Pole itself, and on approaching the same, the component for any point becomes = 0, i. e. equal to the total of all thermal deviations in the parallel-circle.

Several arguments are in favour of the theory, that an increased equalization of the thermal elements takes place in proportion as the space itself decreases. A concentrated area of land or water and of comparatively small dimensions cannot, wherever it is placed on the earths surface, exhibit any considerable difference of temperature, particularly not, when the total area and its surroundings are of equal physical constitution, as is the case in the regions surrounding the pole, which only form a small part of the deep, polar ocean*). The meridians are moreover so near each other**), that for many degrees of longitude, if not for the total circumference, the same annual temperature most probably would be found.

At the same time as a correction on the above principles of the annual thermo-geographical component was devised, and a first approximation, starting from $t_{\varphi,\ \lambda}$ in the parallel of $85^0 = 0$, applied, the means of the numerical values, given in Tab. II and IV for the parallels 60—65 and 70°, were employed in order to maintain the continuity with the thermal conditions in limitrophe parallels, and in this manner to establish the formation of the arctic table on a sound and most reliable basis; the correction of the figures, given in Tab. II and IV, calls for no further explanation, and the difference is also for most of the positions but inconsiderable. The effective correction is consequently restricted to parallels north of 70°, the value of those of 70—65 and 60° being thus preserved.

The following scheme examplifies for Greenwich meridian the operations, which were required to complete the table for this meridian; three series of differences are employed and indices fixed to 5° lat.

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*) The area encircled by the parallel 87° 30′ contains 4453 □ geogr. miles, and by the parallel 85° 17,676 □ g. m.; for comparison be named, that these figures represent about the territories of British Guyana and Venezuela in the tropical zone.

**) The length of 1° long. at 87½° and 85° lat. is equal to 0,658 and 1,313 g. m. respectively.

We have then for the first approximation for the values of $t\varphi,\ \lambda$

φ	$t\varphi,\ \lambda$
85° ..	0
80° ..	—
75° ..	—
70° ..	+10,178
65° ..	+10,810
60° ..	+ 9,219

and the first terms of the three series of differences Δ_1 Δ_2 and Δ_3 are now determined by the three equations

$$10{,}178 = 3\,\Delta_1 + \frac{3\,.\,2}{1\,.\,2}\,\Delta_2 + \frac{3\,.\,2\,.\,1}{1\,.\,2\,.\,3}\,\Delta_3$$

$$10{,}810 = 4\,\Delta_1 + \frac{4\,.\,3}{1\,.\,2}\,\Delta_2 + \frac{4\,.\,3\,.\,2}{1\,.\,2\,.\,3}\,\Delta_3 \quad \text{and}$$

$$9{,}219 = 5\,\Delta_1 + \frac{5\,.\,4}{1\,.\,2}\,\Delta_2 + \frac{5\,.\,4\,.\,3}{1\,.\,2\,.\,3}\,\Delta_3$$

from which

$$\Delta_1 = +\ 4{,}2676$$
$$\Delta_2 = -\ 0{,}7064$$
$$\Delta_3 = -\ 0{,}5055$$

we get now the series of $t\varphi,\ \lambda$ for Greenwich meridian

		Δ_1	Δ_2	Δ_3
85° ..	0			
		+ 4,2676		
80° ..	+ 4,2676		— 0,7064	
		+ 3,5612		— 0,5055
75° ..	+ 7,8288		— 1,2119	
		+ 2,3493		— 0,5055
70° ..	+10,1781		— 1,7174	
		+ 0,6319		— 0,5055
65° ..	+10,8100		— 2,2229	
		— 1,5910		
60° ..	+ 9,2190			

The second approximation relates only to the lat. 85°, for the correction of which we have from the above series

		Δ_1	Δ_2
70° ..	+10,178		
		— 2,349	
75° ..	+ 7,829		— 1,212
		— 3,561	
80° ..	+ 4,268		— 1,212
		— 4,773	
85° ..	— 0,505		

In the complete table we find then for Greenwich meridian and for the following latitudes the value of $(t\varphi,\ \lambda)$, and, when the normal temperature of the parallels is added, the mean yearly temperature at the corresponding positions, as follows:

	Pole	87° 30′	85°	80°	75°	70°	65°	60°	
$t\varphi,\ \lambda$ =	0	0	— 0,505	+ 4,268	+ 7,829	+10,178	+10,810	+ 9,219	°C
$T\varphi$ =	—21,762	—20,341	—18,853	—15,686	—12,295	— 8,721	— 5,013	— 1,225	
$T\varphi,\ \lambda$ =	—21,762	—20,341	—19,358	—11,418	— 4,466	+ 1,457	+ 5,797	+ 7,994	

The effect of the corrections, applied to the arctic table of temperature on the above principles, is most clearly demonstrated by the amplitude or difference of the extreme annual temperature within the region from 90° West to 90° East, as shown in the following table:

	Before correction	After correction
Approaching the Pole ..	18,976 °C	0
At the parallel of 85° ..	16,185	3,724 °C
80° ..	14,536	11,265
75° ..	13,964	15,827
70° ..	16,522	16,522

The revised and completed table of the annual thermo-geographical component (t_φ, λ) of arctic positions is included in the Codification (Part IX); the table has been employed in the following continuation of recearches, concerning places and positions in the polar regions.

On examining the table, annexed the arctic sketch and produced page 117, the same will be found to show the observed and calculated mean yearly temperature of 17 places, out of which 2 are derived from incomplete series and 6 from one-years observations at different periods; the remaining 9 stations give regular observations from Greenland (South), Iceland, the Færøe and Shetland Isles and Norway. All stations are situated on islands or immediate at the shore and thus placed under the full action of the ocean. — 3 stations are situated just at the verge of the arctic circle, 9 north and 8 south of the same, 3 calculatory positions included.

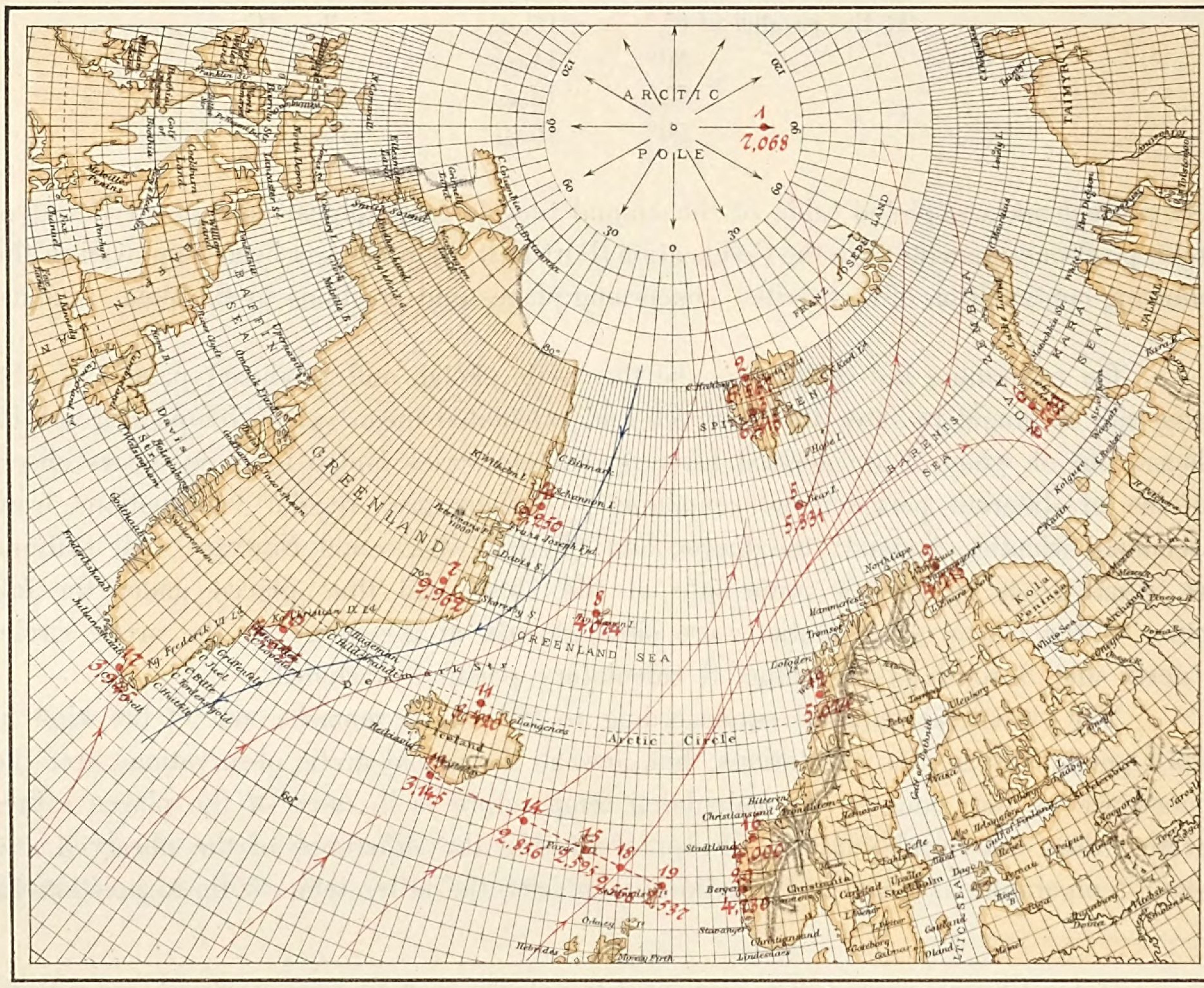
The statistical material is, according to the above remarks, not of the kind to afford good averages for all stations, but, few as the actual arctic observations are, the accordance of the same to the calculated temperature is in most of the places rather greater, than one would expect. In proof of this the difference of the observed and calcul. temperature is given in the following table*); the latter temp. is up to position 12

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*) The following abstract of a more complete collection may be found of interest, and is therefore given here in addition to the arctic sketch and table.

		period years	mean yearly temp. obs.	calcul.	diff.	φ	λ	h
Greenland, South ..	Ivigtut	19	+0,83 °C	+0,73 °C	+0,10 °C	61° 12′	48° 11′ W.	5
Iceland, North	Akureyri	23	+2,28	+3,09	−0,81	65° 39′	18° 10′	3
West .. .	Bordeyri	8	+1,24	+3,01	−1,77	65° 13′	21° 10′	2
	Stykkisholm .	23	+2,84	+2,82	+0,02	65° 5′	22° 46′	11
	Reykjavik ..	23	+4,00	+3,66	+0,34	64° 9′	22° 0′	5
	Havnefjord ..	8	+3,63	+3,73	−0,10	64° 4′	22° 0′	3
East	Papey	8	+1,68	+4,27	−2,59	64° 30′	14° 13′	28
	Berufjord ..	23	+2,65	+4,19	−1,54	64° 40′	14° 15′	18
Færøe Isles	Klaksvig	8	+6,36	+6,43	−0,07	62° 15′	6° 39′	0
	Kvalbø	8	+7,28	+6,79	+0,49	61° 39′	7° 6′	0

SKETCH OF ARCTIC REGIONS.



NOTES.

1. The thermo-geographical elements of the positions and places, enumerated on the sketch, are given in the annexed table.
2. The figures denote the observed or calculated value of the thermo-geographical coefficient MV.
3. The curves are drawn with a view to mark the relation between the direction of the arctic currents, the general configuration of the territory, and the numerical value of the coefficient MV.

PROSPECT OF THERMO-GEOGRAPHICAL ELEMENTS OF ARCTIC POSITIONS AND PLACES.

Nr.	Place	Situation	φ	λ	h	Period of Observ.		Authority and remarks
						years	years specif.	
1	Nansens Point	Polar Ocean	86° 14′	90° 0′ E.	0	—	—	Obs. not yet published
2	Mosselbay	Spitzbergen, North Coast	79° 53′	16° 4′ E.	11	1	1872—73	Chall. Rep.
3	Torsden	Spitzbergen, West Coast	78° 28′	15° 43′ E.	0	1	1882—83	Chall. Rep.
4	Sabine Island	Greenland, East Coast	74° 32′	18° 49′ W.	—	1	1869—70	Chall. Rep.
5	Bear Island	Barents Sea	74° 39′	18° 48′ E.	0	1	1865—66	Chall. Rep.
6	Kurmakuli	Novaja Semlia, West Coast	72° 23′	52° 42′ E.	7	1	1882—83	Chall. Rep.
7	Isle of Denmark	Greenland, East Coast	70° 27′	26° 12′ W.	0	11/12	1891—92	Capt. Ryder, R. D. N., Met. Inst., Copenh.
8	Jan Mayen	Greenland Sea	70° 59′	8° 28′ W.	10	1	1882—83	Chall. Rep.
9	Vardö	Norway, North Coast	70° 22′	31° 7′ E.	10	15	1870—84	Chall. Rep.
10	Angmagsalik	Greenland. East Coast	65° 37′	37° 16′ W.	0	8/12	1884—85	Capt. Holm, R. D. N., Met. Inst., Copenh.
11	Grimsey	Iceland, North (Island)	66° 34′	18° 3′ W.	3	23	1870—92	Chall. Rep. and Met. Inst., Copenh.
12	Bodö	Norway, West Coast	67° 17′	14° 24′ E.	5	15	1870—84	Chall. Rep.
13	Vestmanö	Iceland, South (Island)	63° 26′	20° 18′ W.	8	23	1870—92	Chall. Rep. and Met. Inst., Copenh.
14	Midpoint of 13-18	North Atlantic	62° 27′	12° 3′ W.	0	—	—	—
15	Thorshavn	Færøe Isles, East Coast	62° 3′	6° 44′ W.	9	23	1870—92	Chall. Rep. and Met. Inst., Copenh.
16	Aalesund	Norway, West Coast	62° 26′	6° 9′ E.	14	15	1870—84	Chall. Rep.
17	Nennortalik	Greenland, South, West Coast	60° 8′	45° 12′ W.	9	10	1883—92	Met. Inst., Copenh.
18	Midpoint of 15-19	North Atlantic	61° 27′	3° 48′ W.	0	—	—	—
19	North Unst	Shetland Isles	60° 51′	0° 53′ W.	70	15	1870—84	Chall. Rep.
20	Bergen	Norway, West Coast	60° 24′	5° 10′ E.	17	15	1870—84	Chall. Rep.

Nr.	Place	mean yearly temp.			*MV*		Nr.	Place	mean yearly temp.			*MV*	
		obs.	calculated		obs.	calcul.			obs.	calculated		obs.	calcul.
			general form.	arctic table						general form.	arctic table		
1	Nansens Point	—	—19,604	—19,510	—	7,068	11	Grimsey	+ 1,45	+ 2,406	+ 1,572	3,420	—
2	Mosselbay	— 9,26	— 5,070	— 7,785	6,567	—	12	Bodö	+ 3,86	+ 2,251	+ 2,149	5,074	—
3	Torsden	— 5,64	— 4,196	— 5,619	6,415	—	13	Vestmanö	+ 5,23	+ 4,453	—	3,145	—
4	Sabine Island	—11,68	— 4,350	— 4,414	9,250	—	14	Midpoint of 13-18	—	—	—	—	2,856
5	Bear Island	— 5,21	— 1,994	— 2,086	5,331	—	15	Thorshavn	+ 6,37	+ 6,542	—	2,595	—
6	Kurmakuli	— 6,62	— 6,155	— 6,527	6,729	—	16	Aalesund	+ 6,75	+ 6,058	—	4,000	—
7	Isle of Denmark	(—11,03)	— 2,010	— 1,411	(9,362)	—	17	Nennortalik	(+ 0,30)	+ 2,027	—	3,945	—
8	Jan Mayen	— 2,31	— 0,188	— 0,571	4,074	—	18	Midpoint of 15-19	—	—	—	—	2,566
9	Vardö	+ 0,46	— 1,206	— 0,041	4,715	—	19	North Unst	+ 7,22	+ 6,905	—	2,537	—
10	Angmagsalik	(— 2,53)	— 0,196	+ 0,521	(4,625)	—	20	Bergen	+ 6,73	+ 7,194	—	4,730	—

calculated from the arctic table and for the rest from the general formulæ, the arctic circle forming the limiting parallel.

		obs.	calcul.	difference western quadrant	difference eastern quadrant
2	Mosselbay	— 9,26 °C	— 7,79 °C	—	— 1,47
3	Torsden	— 5,64	— 5,62	—	— 0,02
4	Sabine Island	—11,68	— 4,41	— 7,27	—
5	Bear Island	— 5,21	— 2,09	—	— 3,12
6	Kurmakuli	— 6,62	— 6,53	—	— 0,09
8	Jan Mayen	— 2,31	— 0,57	— 1,74	—
9	Vardö	+ 0,46	— 0,04	—	+ 0,50
11	Grimsey	+ 1,45	+ 1,57	— 0,12	—
12	Bodö	+ 3,89	+ 2,15	—	+ 1,71
13	Vestmanö	+ 5,23	+ 4,45	+ 0,78	—
15	Thorshavn	+ 6,37	+ 6,54	— 0,17	—
16	Aalesund	+ 6,75	+ 6,06	—	+ 0,69
17	Nennortalik	+ 0,30	+ 2,03	— 1,73	—
19	North Unst	+ 7,22	+ 6,91	+ 0,31	—
20	Bergen	+ 6,73	+ 7,19	—	— 0,46

From this list it will be seen, that in fact only two places, Sabine Island and Bear Island, produce an unusual large difference, while all the other places give very good, some of them almost identical results; the little island of Grimsey (23 years), Vardø (15 years), Torsden and Kurmakuli (Spitzbergen and Novaja Semlia, polar Expedition 1882—83, hourly observations), Thorshavn (23 years), North Unst (15 years) and Bergen (15 years) belong to this class.

The eastern quadrant seems again to give better results, and on comparing the observed and calculated temperature of the arctic places, given on page 117, the revised and codified table of arctic temperature will no doubt be found an improvement, the temperature calculated from the same as a rule approximating more the actual observations, than is the case with the temperature, derived from the general formulæ. This was the object aimed at by the formation of the arctic table.

Completion of interrupted series of observations.

66. The incomplete series of observations of temperature at *Angmagsalik* and the *Isle of Denmark*, published in 1889 and 1895 by the Meteorological Institute, Copenhagen, contain for 8 and 11 months respectively the following data:

Angmagsalik

January 1885	— 5,3 °C	July 1885	— °C
February —	—15,1	August —	—
March —	— 8,6	September —	—
April —	— 3,7	October 1884	—1,8
May —	+ 0,8	November —	—4,7
June —	—	December —	—5,5

Isle of Denmark

January 1892	—18,53 °C	July 1892	+ 4,42 °C
February —	—24,26	August —	—
March —	—25,47	Septbr. 1891	— 2,98
April —	—17,11	October —	— 7,01
May —	— 5,07	November —	—20,24
June —	+ 1,10	December —	—20,33

On looking over the series it is easy to see, that they are not only incomplete, but very irregular; the fortunate circumstance will, however, also be observed, that both series contain observations from the 6 consecutive winter months (November—April)*), in these researches frequently designed as the negative months. This circumstance, combined with the principle, that the actual observations should be reproduced in the completed series, makes it possible to establish the following method and relations.

The observations leave the two factors M and MV as well as the temperature of the missing months undecided. The actual observations and the formulæ give now the numericals for the establishment of the required 3 equations for the unknown quantities and for each of the two places:

Angmagsalik	*Isle of Denmark*
$M = \frac{-43,_9 + y}{12}$	$M = \frac{-135,_{48} + y}{12}$
$MV = \frac{6\,M + 42,_9}{6}$ and	$MV = \frac{6\,M + 125,_{94}}{6}$ and
$y = 5,_{1242}\,MV + 4\,M$	$y = 1,_{4228}\,MV + M$

from which

$M = -\ 2,_{5255}\ ^0C$	$M = -11,_{0284}\ ^0C$
$MV = \quad 4,_{6245}$	$MV = \quad 9,_{9616}$
$y = \Sigma\,(t_{6-9}) = +\ 13,_{5940}$	$y = t_8 = +\ 3,_{1392}$

We give below the actual observations, the completion and the normal series of temperature for both places; in the Angmagsalik series the total temperature of June—September $= 13,_{594}$ is distributed according to the general formulæ.

Angmagsalik

	obs.	compl.	normal
January 1885	— 5,3	—	—10,1646 °C
February „	—15,1	—	— 8,7874
March „	— 8,6	—	— 6,7891
April „	— 3,7	—	— 3,0331
May „	+ 0,8	—	+ 0,6405
June	—	+ 3,1973	+ 3,1973
July	—	+ 4,6122	+ 4,6122
August	—	+ 4,0542	+ 4,0542
September	—	+ 1,7307	+ 1,7307
October 1884	— 1,8	—	— 1,6451
November „	— 4,7	—	— 5,4218
December „	— 5,5	—	— 8,7040
$M =$	— 2,5255	— 2,5258	
$MV =$	4,6246	4,6241	

Isle of Denmark

	obs.	compl.	normal
January 1892	—18,53	—	—27,4837 °C
February „	—24,26	—	—24,5172
March „	—25,47	—	—20,2126
April „	—17,11	—	—12,1217
May „	— 5,07	—	— 4,2085
June „	+ 1,10	—	+ 1,2991
July „	+ 4,42	—	+ 4,3470
August	—	+ 3,1392	+ 3,1448
Septbr. 1891	— 2,98	—	— 1,8601
October „	— 7,01	—	— 9,1231
November „	—20,24	—	—17,2673
December „	—20,33	—	—24,3375
$M =$	—11,0284	—11,0284	
$MV =$	9,9616	9,9616	

*) It may often happen to arctic expeditions and explorers, that observations during the winter season are provided for; a reliable method for completing such series may therefore not unfrequently be of use. — Observations from the summer season are of course just as serviceable.

According to the formula for completion, the — 43,9 °C and — 135,48 °C for respectively 8 months in the Angmagsalik and 11 months in the Isle of Denmark series are reproduced in the completed series, and the general character of the observed series is thus preserved; on comparing the series it will moreover be found, that the temperature of the seasons, or of several months taken together, is almost the same in the observed and the calculated series; it is of special interest to note the insignificant difference of temperature in the two Angmagsalik series assigned to April and May and to October and November, which reflects upon the completing terms (June to September) a high degree of probability. Similar remarks refer to the months of May to September in the Isle of Denmark series.

The extreme low temperature at the Isle of Denmark (1891—92), almost as low as that observed at the Sabine Island (1869—70), 4° further north, is no doubt due to the exceptional state of ice, observed during the year 1891.*) The extraordinary great difference of the observed and calculated temperature at the two places is probably due to such abnormal deviations in respect to the state of ice etc. from the average conditions, for which the formulæ are calculated.

The calculated numerical value of the thermo-geographical coeff. *MV* corresponds precisely to the different situations of the completed places. *Angmagsalik,* immediate at the deep ocean, and by the curvature of the coast line to some extent protected from northern influence, has a low coefficient = 4,625, only a fraction of a degree higher than *Nennortalik* = 3,945, and like this place exposed to the free and constant action of southerly currents. The *Isle of Denmark,* however, lies about midways in the narrow fjords of Scoresby Sound, or 80 to 100 naut. miles from the ocean; this continental situation in the high latitude is numerically expressed by the coefficient *MV* = 11,028; the same, as well as the *Sabine Islands* = 9,250, is again in perfect harmony with and similar to the coefficient of places along the coast of Labrador, in situations quite analogical with those, which regulate the annual movement of temperature on the eastern coast of North-Greenland.

It may then be concluded, that the above method can be applied to incomplete series of temperature observations with every prospect for obtaining an acceptable compensation for the missing terms.

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*) „Isforholdene i Nordhavet, 1877—1892", by Capt. C. Ryder. Copenhagen, 1896. — The edge of the ice was in April—May 1891 observed to reach and even to pass the meridian 10° E., and thus the ice covered the Greenland Sea for a distance of about 600 naut. miles in the direction E. N. E. from Scoresby sound.

On the probable temperature at Nansens Point. 86°14′ lat. N., 90° long. E.

67. The success, attending the application of the arctic table to such northerly places as *Mosselbay, Torsden* and *Kurmakuli,* at Spitzbergen and Novaja Semlia, renders it now an easy task to ascertain the probable mean yearly temperature of any position within the limits, prescribed by this table. It is only when the entire thermal position, including the temperature of the months, is to be determined, that certain difficulties are met with, which also may be overcome, provided that the general physical character of the surroundings of the given geographical position is known.

The studies on arctic temperature were so far advanced, when the intense emotion, created by Dr. *Fridtjof Nansens, his followers and „Frams“* happy return from the most eventful and successful arctic expedition, caused the Author in view of the interesting situation to submit the analytical method to a severe test; for this purpose the required calculations were made and the following memorandum subsequently prepared and under the date of October 17, 1896, deposited at the Smithsonian Institution, Washington, intentionally before any publication on the part of the expedition had taken place beyond the facts communicated by Professor *Mohn,* Christiania, and which are mentioned in the memorandum.

„In the informations found in public papers concerning Dr. Fridtjof Nansens „recent Polar Expedition it is stated, that he reached the northermost point „at the lat. 86° 14′ in about the long. 90° E., and that the Expedition „succeeded in proving the existence of a deep polar ocean with depths of „upwards to 3800 metres, and showing traces of the Gulf stream; no con- „tinent was observed. — Based upon these observations from regions hitherto „unexplored I have, by means of the formulæ and methods laid down in „my treatise „thermo-geographical Studies“, calculated the temperature at the „above geographical position as follows

mean yearly temperature = $-19{,}_{6}$ °C, and

„the normal mean monthly temperature

January . .	$-31{,}_{16}$ °C	May	$-14{,}_{81}$ °C	September .	$-13{,}_{16}$ °C
February .	$-29{,}_{08}$	June	$-10{,}_{94}$	October . .	$-18{,}_{26}$
March . .	$-26{,}_{05}$	July	$-8{,}_{80}$	November .	$-23{,}_{98}$
April . . .	$-20{,}_{37}$	August . .	$-9{,}_{64}$	December . .	$-28{,}_{95}$

„It is consequently of importance for the further application of the „formulæ in regard to other parts of the polar regions, that the above „calculations be confirmed by the precise observations made during the pro- „tracted and most successful expedition; awaiting now the publication and „the corroborative effect of the same, I am inclined in the interest of the „matter to add the remark, that at the North Pole itself most probably a „temperature will be found only a few degrees lower than the above, pro- „vided that the deep polar Ocean extends beyond Dr. Nansens turning-point.“

It remains now to produce an abstract of the principles and the numerical relations forming the basis for the above determinations, which by a subsequent revision have been modified, but only by small fractions of a degree centigrade.

From the arctic sketch and the tables accompanying the same (page 116 and 117) it will be seen, that the elements of the thermal position of Nansens Point have been determined as follows:

the mean yearly temperature $= -19{,}51$ °C and
the thermo-geographical coefficient $= 7{,}068$

The mean yearly temperature is interpolated from the arctic tables of temperature, from which we have for Nansens Point

$$t\varphi, \lambda = 0 - 0{,}75 \,.\, 0{,}090 + 0{,}0937 \,.\, 1{,}727 = + 0{,}094\ ^0\text{C}$$
$$T\varphi = -21{,}762 + 0{,}75 \,.\, 2{,}909 - 0{,}0937 \,.\, 0{,}258 = -19{,}604$$

the sum of which is equal to $-19{,}510$ °C, as above. — The inconsiderable thermo-geographical component $= + 0{,}094$ °C is just enough to indicate at Nansens point the presence of some southerly, the normal temperature at the lat. 86° 14′ slightly moderating influence.*)

The numerical determination of the thermo-geographical coefficient *MV* at Nansens or at any other arctic point is founded upon principles analogical with those, exposed in the special researches on the movement of the coefficient along different parallels, particularly that of 50° N. (§ 44—45, plan II). — The researches have shown, that the coefficient, when advancing through a continent of uniform configuration, increases in direct proportion to the distance from the oceans, and that this movement is further regulated by starting points and points of inflexion, determined by oceanic, intermediate or terminal influence.

The figures, inscribed on the arctic sketch, denote the numerical value of the coefficient *MV* at the points of observation (islands and shore stations), marked on the sketch; an examination of the coefficients shows now an increase towards North, which at the first sight and for the greater part of the places is almost as regular as has been observed in the purely continental movement. It is further evident, that in the eastern part of this arctic region, from West of Spitzbergen, Jan Mayen and Iceland towards Norway and Novaja Semlia one and the same regulating power is at work, while nearer the eastern coast of Greenland the influence is of quite another character. The curves on the sketch show more prominently this parallelism of figures and oceanic action, and the arrows attached mark, too, the direction of the regulating force. On considering all the moments thus brought forward the conclusion is no

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*) It needs scarcely be remarked, that references to such small quantities are not made for practical purposes, but only in order to mark in a convenient manner the general tendency of tables and formulæ.

doubt, that the total ensemble represents, numerically, the constant action of the Gulf stream and the polar current, modified by the distance and situation of the places of observation.

Formation of the starting point. The determination of the value of the coefficient *MV* at the position, forming the starting point, is one of great importance for the sake of securing the precision of all further operations. The stations at *Vestmanø* (13), *Thorshavn* (15) and *North Unst* (19) are selected for this purpose, not only on account of the excellent series of observations, but also for the distinct insular situation of these places. The midpoint of Thorshavn—North Unst was first ascertained and then the midpoint of this position and Vestmanø; the starting point and the corresponding value of the coefficient *MV* is accordingly found in the position

$62^{\circ}\ 27'$ lat. N. $12^{\circ}\ 3'$ long. W. and $MV = 2{,}_{856}\ ^{\circ}C.$

The shortest (great circle-) distance*) from the starting point to positions, shown on the arctic sketch, has then been determined; as the complete table of distances thus calculated in many other respects may be of interest the same is given here, and for comparison the proportionate increase (+) or decrease (—) of the coefficient *MV* calculated per 100 naut. miles, and the direction in which the two stations are placed to each other.

Starting point			
to Jan Mayen (8)	519 n. m.	$2{,}_{856}/4{,}_{074}$	$+0{,}_{235}$
Bear Island (5)	974 n. m.	$2{,}_{856}/5{,}_{331}$	$+0{,}_{254}$
Mosselbay (2)	1150 n. m.	$2{,}_{856}/6{,}_{567}$	$+0{,}_{323}$
Nansens Point (1)	1620 n. m.	$16{,}_{20} . 0{,}_{260} + 2{,}_{856} = 7{,}_{068}$**)	

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*) The distance $= d$, expressed in degrees of the great circle between the two given points ($1^{\circ} = 60$ naut. miles), is calculated from the formula $\cos d = \frac{\sin \varphi_1 \cos n}{\cos m}$

in which

φ and λ denote the lower lat. and corresponding long.
φ_1 and λ_1 denote the higher lat. and corresponding long.
$\cos m$ is computed from tang. $m = \mathrm{cotg}\ \varphi_1 \cos(\lambda - \lambda_1)$, and
$\cos n$ . . . . . from $n = 90^{\circ} - \varphi$ — arc tang. m

The formula $\cos d = \sin \varphi \sin \varphi_1 + \cos \varphi \cos \varphi_1 \cos(\lambda - \lambda_1)$ may also be employed.

**) The increase of $0{,}_{250}$ per 100 n. m. is the result of giving the Jan Mayens and Bear Islands coeff. double weight of that of Mosselbay, or ratio of *MV* to Nansens Point $= \frac{2 . 0{,}_{235} + 2 . 0{,}_{254} + 0{,}_{323}}{5} = 0{,}_{260}$; the Mosselbay coefficient appears namely to be somewhat too high, probably owing to the situation of the bay, which opens toward North; to compensate for this circumstance the Mosselbay coeff. is, as shown, given less influence. There are besides other moments, for inst. the coeff. of Torsden, which are in favor of this regulation.

Points of observation.

Mosselbay to	Nansens Point (1)	585 n. m.	$+0_{,085}$ N.
	Kurmakuli (6)	672 n. m.	$+0_{,024}$ SE.
	Bear Island (5)	317 n. m.	$-0_{,390}$ S.
	Jan Mayen (8)	639 n. m.	$-0_{,390}$ SW.
	Sabine Island (4)	549 n. m.	$+0_{,489}$ W.
Bear Island to	Nansens Point (1)	874 n. m.	$+0_{,199}$ N.
	Mosselbay (2)	317 n. m.	$+0_{,390}$ N.
	Kurmakuli (6)	584 n. m.	$+0_{,239}$ E.
	Vardö (9)	338 n. m.	$-0_{,182}$ SE.
	Jan Mayen (8)	524 n. m.	$-0_{,240}$ SW.
	Sabine Island (4)	590 n. m.	$+0_{,664}$ W.
Jan Mayen to	Mosselbay (2)	639 n. m.	$+0_{,390}$ NE.
	Bear Island (5)	524 n. m.	$+0_{,240}$ NE.
	Vardö (9)	772 n. m.	$+0_{,083}$ E.
	North Unst (19)	634 n. m.	$-0_{,242}$ SE.
	Thorshavn (15)	536 n. m.	$-0_{,276}$ S.
	Grimsey (11)	337 n. m.	$-0_{,194}$ SW.
	Isle of Denmark (7)	353 n. m.	$+1_{,668}$ W.
	Sabine Island (4)	279 n. m.	$+1_{,855}$ NW.
Grimsey to	Jan Mayen (8)	337 n. m.	$+0_{,194}$ NE.
	Angmagsalik (10)	479 n. m.	$+0_{,252}$ W.
Vardö to	Kurmakuli (6)	428 n. m.	$+0_{,470}$ E.
Vestmanö to	Angmagsalik (10)	457 n. m.	$+0_{,324}$ W.

The table shows, that the coefficient *MV* increases in all directions from N. to E. and W. to NW., but decreases in all southerly directions (SE., S. and SW.), quite in accordance with the system of permanent currents, prevailing in this region. A further discussion of the contents of the table may, however, be postponed and included in more extended investigations.

The result of the present studies on arctic temperature, when concentrated in the question of temperature at Nansens Point, $86^0\,14'$ lat. N. and 90^0 long. E. (?), is given in the following revised table (November 22, 1896):

the mean yearly temperature	$-19_{,510}\,^0$C
the thermo-geographical coefficient *MV*	$7_{,068}$

from which the normal mean temperature of the months is determined as follows:

January	—31,185 °C	July	— 8,601 °C
February	—29,081	August	— 9,454
March	—26,026	September	—13,005
April	—20,286	October	—18,158
May	—14,671	November	—23,937
June	—10,763	December	—28,953

VIII.

ON THE SYSTEMATIC, NUMERICAL REPRESENTATION OF THE DISTRIBUTION OF TEMPERATURE OVER THE SURFACE OF THE EARTH.

68. In part V, § 40 and 43, reference has been made to the proposed plan for a systematic, numerical representation of the thermo-geographical factors t_φ, λ and MV; when combined with the normal and constant quantities, T_φ, Q_m and $\frac{6\,Q_m}{\Sigma(+\,Q_m)}$, they afford the means for a convenient determination of the mean yearly and normal monthly temperature at sea-level of any place within the limits of the map or table.

The thermo-geographical factors, inscribed on suitable maps according to this plan, give at the same time a distinct prospect of the movement of the terrestrial factors, which permanently partake in the distribution or regulation of temperature over that territory or particular region, represented on the map.

The following scheme examplifies the proposed plan.

	W. 90°	80°	70°	60°	50°	0°	10°	20°	30° E.
60° N.	$-6{,}488$	$-6{,}894$	$-5{,}518$	$-3{,}465$	$+1{,}935$	$+9{,}219$	$+7{,}321$	$+6{,}081$	$+4{,}744$
	$14{,}76$	$12{,}48$	$10{,}19$	$7{,}91$	$5{,}62$	$2{,}80$	$7{,}06$	$7{,}17$	$8{,}61$
55°	$-6{,}079$	$-6{,}616$	$-5{,}648$	$-5{,}677$	$+0{,}894$	$+7{,}436$	$+6{,}032$	$+4{,}574$	$+3{,}240$
	$13{,}72$	$11{,}74$	$9{,}86$	$8{,}84$	$4{,}86$	$3{,}88$	$5{,}46$	$6{,}76$	$8{,}32$
50°	$-4{,}467$	$-5{,}825$	$-5{,}647$	$-5{,}463$	$-1{,}139$	$+5{,}207$	$+4{,}111$	$+2{,}923$	$+1{,}791$
	$12{,}27$	$10{,}90$	$9{,}54$	$7{,}62$	$4{,}80$	$4{,}15$	$6{,}33$	$6{,}86$	$8{,}31$
45°	$-2{,}590$	$-3{,}928$	$-3{,}521$	$-1{,}841$	$+1{,}014$	$+2{,}888$	$+3{,}011$	$+2{,}640$	$+2{,}110$
	$10{,}57$	$9{,}56$	$8{,}56$	$6{,}69$	$4{,}62$	$5{,}28$	$6{,}88$	$7{,}08$	$7{,}56$

In this scheme the upper figures represent for the given position the annual thermo-geographical component (t_φ, λ), positive or negative*), and the lower figures the thermo-geographical coefficient MV, always taken positive.

On the map should besides be found tables of the completing general terms, T_φ for the parallels and Q_m and $\frac{6\ Q_m}{\Sigma(+\ Q_m)}$ for the months, to which may be added special tables, showing the correction for height applicable in the various districts, formulæ for Interpolation, tables of geodætical measures etc. Thus all quantities required for the precise determination of the mean yearly and monthly temperature by means of simple numerical operations are at hand and conveniently arranged.

In § 40 and several other paragraphs some examples are given of the effect of the interpolating method as based upon the systematic, numerical representation of the thermo-geographical functions.

The „geographical table“, presented in part V page 76 and 77, offers another scheme, which perhaps also may be found suitable, eventually for replacing the common tabular representations.

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*) If the figures be marked in colours (red and blue), as shown in Pl. I, this would enable the reader at a glance to comprehend the movement of this important geo-physical element.

IX.

CODIFICATION OF THE PRINCIPAL THERMO-GEOGRAPHICAL TABLES, FORMULÆ AND DEFINITIONS.

Remarks on the Codification and its contents.

69. The following Codification of the principal tables and formulæ, the numerical terms and the definitions, in some instances accompanied by examples, has been arranged with a view to facilitate the application of the analytical method in geo-physical and meteorological investigations. The collection forms a summary of the general results, obtained through the present studies on the thermo-geographical problem, and is arranged as follows:

A. General formulæ and tables.

1. *Formulæ for determining the normal mean yearly temperature of the Parallels.*
2. *Formulæ for reduction of temperature to mean latitude.*
3. *Table for Interpolation of the normal mean yearly temperature of the Parallels.*
4. *Table showing mean latitude of different Isothermals for the year.*
5. *Mean temperature of the Globes surface.*

B. Formulæ, tables and definitions for the year.

1. *Formulæ and definitions for determining the mean yearly temperature at sea-level of places, situated in the Atlantic middle-zones of the Northern Hemisphere.*
2. *Revised and completed table for Interpolation of the geographical component of the mean yearly temperature of positions in the Atlantic middle-zones of the Northern Hemisphere.*

C. Formulæ, coefficients and definitions for the months.

1—6. General formulæ and definitions for the determination for all zones of the normal monthly distribution of the given, observed or calculated mean yearly temperature.

7—9. Definition and determination of the thermal order of the months.

10—11. Definition and determination of the meteorological series.

D. Proposed numerical classification of climates.

E. General remarks. — Conclusion.

Completion of tables for Interpolation

With one single exception, all the data, enumerated in the Codification, have been fully dealt with and proved in Part I—VII of these studies. The exception alluded to concerns the tropical part of the revised table for Interpolation of the annual thermo-geographical component, which it was found useful, if possible, to add to the parts relating to the arctic regions and the temperate zone.

The numericals, given for the tropical zone, have only lately (1897) been determined on the same principles as those, on which the table for the arctic regions was founded (§§ 17, 64—67). A further explanation is therefore not required, and it is sufficient to state, that the formation of the series for the parallels of lat. 20^0—15^0 and 10^0 N. has been based upon the tabulated values of the component for the parallels of lat. 35^0—30^0 and 25^0, combined with the assumed value $= 0$ for the equatorial zone.

The table, thus completed, presents therefore now a number of systematically arranged numericals, which, combined with the codified table for the parallels, reduces to ordinary interpolation all the calculations required for the determination of the mean yearly temperature of places and positions in the Atlantic middle-zones, forming one-half part of the Northern Hemisphere.

70. Formulæ, tables and definitions for the analytical determination of the normal mean yearly temperature of any of the northern and southern Parallels, of the mean yearly temperature of places, situated in the Atlantic middle-zones of the Northern Hemisphere, and of the normal mean monthly temperature of any place of the Northern and Southern Hemisphere.

A. General formulæ and tables.

1. *Formulæ for determining the normal mean yearly temperature of the Parallels.*

NORTHERN HEMISPHERE

$$T_\varphi = 31{,}_{7544}\ cos\ \varphi + 18{,}_{6395}\ cos\ \varphi^2 - 21{,}_{7620}\ ..\ {}^0\text{C} \quad .. \quad (1)$$
$$57{,}_{1579}\ cos\ \varphi + 33{,}_{5511}\ cos\ \varphi^2 - 7{,}_{1716}\ ..\ {}^0\text{F}$$
$$25{,}_{4035}\ cos\ \varphi + 14{,}_{9116}\ cos\ \varphi^2 - 17{,}_{4096}\ ..\ {}^0\text{R}$$

SOUTHERN HEMISPHERE

$$T_\varphi = 10{,}_{0371}\ cos\ \varphi + 28{,}_{3073}\ cos\ \varphi^2 - 11{,}_{6545}\ ..\ {}^0\text{C} \quad .. \quad (2)$$
$$18{,}_{0668}\ cos\ \varphi + 50{,}_{9531}\ cos\ \varphi^2 + 11{,}_{0219}\ ..\ {}^0\text{F}$$
$$8{,}_{0297}\ cos\ \varphi + 22{,}_{6458}\ cos\ \varphi^2 - 9{,}_{3236}\ ..\ {}^0\text{R}$$

2. *Formulæ for reduction of temperature to mean latitude.*

$T_\varphi,\ \lambda =$ the given temperature of the place or Isothermal for the year.

NORTHERN HEMISPHERE

$$cos\ \varphi = 0{,}_{2316}\ \sqrt{T_\varphi,\ \lambda + 35{,}_{2861}} - 0{,}_{8518}\ ..\ \ .. \quad (3)$$

SOUTHERN HEMISPHERE

$$cos\ \varphi = 0{,}_{18795}\ \sqrt{T_\varphi,\ \lambda + 12{,}_{5442}} - 0{,}_{1773}\ ..\ \ .. \quad (4)$$

3. Table for Interpolation of the normal mean yearly temperature of the Parallels.

Northern Hemisphere				Southern Hemisphere			
The equatorial zone 0—10° .. + 27,233 °C				The equatorial zone 0—10° .. + 27,233 °C			
φ	$T\varphi$	Δ	Δ_1	Δ_2	φ	$T\varphi$	Δ	Δ_1	Δ_2
10° ..	+ 27,5874 °C				10° ..	+ 25,6839 °C			
		— 1,2861					— 1,2322		
15° ..	26,3013		— 0,4787		15° ..	24,4517		— 0,4462	
		— 1,7648		+ 0,0347			— 1,6784		+ 0,0450
20° ..	24,5365		— 0,4440		20° ..	22,7733		— 0,4012	
		— 2,2088		+ 0,0428			— 2,0796		+ 0,0555
25° ..	22,3277		— 0,4012		25° ..	20,6937		— 0,3457	
		— 2,6100		+ 0,0505			— 2,4253		+ 0,0645
30° ..	19,7177		— 0,3507		30° ..	18,2684		— 0,2812	
		— 2,9607		+ 0,0558			— 2,7065		+ 0,0716
35° ..	16,7570		— 0,2949		35° ..	15,5619		— 0,2096	
		— 3,2556		+ 0,0606			— 2,9161		+ 0,0764
40° ..	13,5014		— 0,2343		40° ..	12,6458		— 0,1332	
		— 3,4899		+ 0,0634			— 3,0493		+ 0,0791
45° ..	10,0115		— 0,1709		45° ..	9,5965		— 0,0541	
		— 3,6608		+ 0,0648			— 3,1034		+ 0,0797
50° ..	6,3507		— 0,1061		50° ..	6,4931		+ 0,0256	
		— 3,7669		+ 0,0643			— 3,0778		+ 0,0778
55° ..	+ 2,5838		— 0,0418		55° ..	3,4153		+ 0,1034	
		— 3,8087		+ 0,0625			— 2,9744		+ 0,0734
60° ..	— 1,2249		+ 0,0207		60° ..	+ 0,4409		+ 0,1768	
		— 3,7880		+ 0,0593			— 2,7976		+ 0,0672
65° ..	— 5,0129		+ 0,0800		65° ..	— 2,3567		+ 0,2440	
		— 3,7080		+ 0,0542			— 2,5536		+ 0,0594
70° ..	— 8,7209		+ 0,1342		70° ..	— 4,9103		+ 0,3034	
		— 3,5738		+ 0,0485			— 2,2502		+ 0,0493
75° ..	— 12,2947		+ 0,1827		75° ..	— 7,1605		+ 0,3527	
		— 3,3911		+ 0,0414			— 1,8975		+ 0,0381
80° ..	— 15,6858		+ 0,2241		80° ..	— 9,0580		+ 0,3908	
		— 3,1670		+ 0,0337			— 1,5067		+ 0,0261
85° ..	— 18,8528		+ 0,2578		85° ..	— 10,5647		+ 0,4169	
		— 2,9092					— 1,0898		
90° ..	— 21,7620				90° ..	— 11,6545			

Formula for Interpolation .. $T_{\varphi_x} = T\varphi + n\,\Delta + \frac{n\,(n-1)}{1\,.\,2}\,\Delta_1 + \frac{n\,(n-1)\,(n-2)}{1\,.\,2\,.\,3}\,\Delta_2 + \ldots .$

in which $n = \frac{^1/_3\,(\varphi_x - \varphi)\text{ min.}}{100}$

Example. Copenhagen $\varphi = 55^0\,41'$ $n = 0,14$

$T\varphi = 2,5838 - 0,14\,.\,3,8087 - 0,0602\,.\,0,0207$

$= 2,5838 - 0,534 = 2,050$ °C

4. Table showing mean latitude of different Isothermals for the year.

	N. H.	S. H.
Isothermal — 10° C ..	71° 46′	82° 58′
— 5° ..	64° 59′	70° 11′
0° ..	58° 24′	60° 46′
+ 5° ..	51° 48′	52° 25′
+ 10° ..	45° 1′	44° 21′
+ 15° ..	37° 45′	36° 0′
+ 20° ..	29° 30′	26° 30′
+ 25° ..	18° 49′	13° 0′

By the formulæ (1) and (2) the Parallels of equal temperature are found to be of the lat. 48° 49′ North and South and of the temperature = + 7,2245 °C. — From this Parallel and towards the Equator the northern parallels attain a higher temperature, but towards the Pole a lower temperature, than the corresponding southern parallels.

5. *Mean temperature of the Globes surface.*

The constant mean yearly temperature of the Hemispheres and of the total surface of the Globe are, by means of the formulæ (1) and (2) and Bessels dimensions of the Globe, calculated thus:

mean temperature of the Northern Hemisphere .. + 15,385 °C
of the Southern Hemisphere .. + 15,226
of the Globes surface .. .. .. + 15,3

B. Formulæ, tables and definitions for the Year.

1. The mean yearly temperature of a place, situated in one of the specified sections I—VIII of the northern Hemisphere and at sea-level, may be determined in degrees Centigrade by the formula

$$M = T\varphi, \lambda = 31,_{7544}\ cos\ \varphi_1 + 18,_{6395}\ cos^2 \varphi_1 - 21,_{7620} \quad .. \quad (5)$$

in which

$$cos\ \varphi_1 = A\ cos\ \varphi + B\ cos^2 \varphi + C \quad .. \quad .. \quad .. \quad (6)$$

$$log\ 31,_{7544} = 1,_{5018039}$$
$$-\ 18,_{6395} = 1,_{2704343}$$

The numericals and signs of the terms A, B and C in (6) are determined by the special formulæ I—VIII given for each section as stated hereafter.

φ denotes the true latitude of the place and λ the longitude, reckoned from Greenwich Meridian.

The mean yearly temperature of any place is composed as follows:

$$M = T\varphi, \lambda = T\varphi + t\varphi, \lambda + t_h \quad .. \quad .. \quad .. \quad .. \quad .. \quad (7)$$

in which

$M = T\varphi, \lambda$ denotes the mean yearly temperature of the place, observed or calculated.

$T\varphi$ the normal mean yearly temperature of the parallel corresponding to the true latitude φ of the place.

$t\varphi, \lambda = M - T\varphi - t_h$ the annual thermo-geographical component, representing the combined thermal effect of the physical and meteorological system of the place.

t_h correction for height.

M, $T\varphi, \lambda$, $T\varphi$ and $t\varphi, \lambda$ may have any numerical, positive or negative value,

t_h is generally $= 0$ or negative.

The difference $arc\ cos.\ \varphi_1 - \varphi$ represents a displacement in latitude of the position, equivalent to the term $t\varphi, \lambda$.

Section I

$A = a \sin\lambda + b \sin^2\lambda + const$ $\quad$ $B = a_1 \sin\lambda + b_1 \sin^2\lambda + const_1$ $\quad$ $C = a_{11} \sin\lambda + b_{11} \sin^2\lambda + const_{11}$

	a	$= -\ 5{,}98948$,	$log = 0{,}7773891$	a_1	$= +\ 5{,}89857$,	$log = 0{,}7707467$	a_{11}	$= +\ 1{,}32125$,	$log = 0{,}1209850$
0—50° E.	b	$= +\ 5{,}07830$	$= 0{,}7057183$	b_1	$= -\ 4{,}82135$	$= 0{,}6831685$	b_{11}	$= -\ 1{,}29482$	$= 0{,}1122102$
50—90° N.	$const$	$= +\ 2{,}11504$	$= 0{,}3253186$	$const_1$	$= -\ 1{,}57473$	$= 0{,}1972061$	$const_{11}$	$= +\ 0{,}01704$	$= 0{,}2314696_{-2}$

Section II

$A = a \sin\lambda + b \sin^2\lambda + const$ $\quad$ $B = a_1 \sin\lambda + b_1 \sin^2\lambda + const_1$ $\quad$ $C = a_{11} \sin\lambda + b_{11} \sin^2\lambda + const_{11}$

	a	$= +21{,}77053$,	$log = 1{,}3378690$	a_1	$= -14{,}57032$,	$log = 1{,}1634691$	a_{11}	$= -\ 8{,}11544$,	$log = 0{,}9093121$
0—50° E.	b	$= -16{,}32470$	$= 1{,}2128453$	b_1	$= +11{,}37870$	$= 1{,}0560932$	b_{11}	$= +\ 5{,}79514$	$= 0{,}7630641$
0—50° N.	$const$	$= -\ 5{,}04553$	$= 0{,}7029068$	$const_1$	$= +\ 3{,}92441$	$= 0{,}5937744$	$const_{11}$	$= +\ 2{,}36650$	$= 0{,}3741065$

Section III

$A = a \cos\lambda + b \cos^2\lambda + const$ $\quad$ $B = a_1 \cos\lambda + b_1 \cos^2\lambda + const_1$ $\quad$ $C = a_{11} \cos\lambda + b_{11} \cos^2\lambda + const_{11}$

	a	$= +\ 2{,}64787$,	$log = 0{,}4228967$	a_1	$= -\ 3{,}08218$,	$log = 0{,}4888580$	a_{11}	$= -\ 0{,}49323$,	$log = 0{,}6930495_{-1}$
50—90° E.	b	$= -\ 5{,}86332$	$= 0{,}7681438$	b_1	$= +\ 5{,}37581$	$= 0{,}7304443$	b_{11}	$= +\ 1{,}72737$	$= 0{,}2373857$
50—90° N.	$const$	$= +\ 1{,}08710$	$= 0{,}0362695$	$const_1$	$= +\ 0{,}07322$	$= 0{,}8646297_{-2}$	$const_{11}$	$= -\ 0{,}11579$	$= 0{,}0636711_{-1}$

Section IV

$A = a \cos\lambda + b \cos^2\lambda + const$ $\quad$ $B = a_1 \cos\lambda + b_1 \cos^2\lambda + const_1$ $\quad$ $C = a_{11} \cos\lambda + b_{11} \cos^2\lambda + const_{11}$

	a	$= +16{,}57634$,	$log = 1{,}2194847$	a_1	$= -\ 9{,}90779$,	$log = 0{,}9959768$	a_{11}	$= -\ 6{,}68688$,	$log = 0{,}8252235$
50—90° E.	b	$= -26{,}70945$	$= 1{,}4266649$	b_1	$= +16{,}00868$	$= 1{,}2043557$	b_{11}	$= +10{,}79453$	$= 1{,}0332038$
0—50° N.	$const$	$= +\ 1{,}77857$	$= 0{,}2500710$	$const_1$	$= -\ 0{,}39749$	$= 0{,}5993262_{-1}$	$const_{11}$	$= -\ 0{,}36127$	$= 0{,}5578319_{-1}$

Section **V**

	$A = a \sin\lambda + b \sin^2\lambda + const$	$B = a_1 \sin\lambda + b_1 \sin^2\lambda + const_1$	$C = a_{11} \sin\lambda + b_{11} \sin^2\lambda + const_{11}$
	$a = -\ 2{,}02655,\ log = 0{,}3067573$	$a_1 = +\ 2{,}78413,\ log = 0{,}4446895$	$a_{11} = +\ 0{,}36598,\ log = 0{,}5634574_{-1}$
0—50° W.	$b = +\ 3{,}26446 = 0{,}5138115$	$b_1 = -\ 3{,}93672 = 0{,}5951346$	$b_{11} = -\ 0{,}91659 = 0{,}9621739_{-1}$
50—90° N.	$const = +\ 1{,}81712 = 0{,}2593836$	$const_1 = -\ 1{,}23360 = 0{,}0911744$	$const_{11} = +\ 0{,}06596 = 0{,}8192806_{-1}$

Section **VI**

	$A = a \sin\lambda + b \sin^2\lambda + const$	$B = a_1 \sin\lambda + b_1 \sin^2\lambda + const_1$	$C = a_{11} \sin\lambda + b_{11} \sin^2\lambda + const_{11}$
	$a = +12{,}71012,\ log = 1{,}1041497$	$a_1 = -10{,}00184,\ log = 1{,}0000797$	$a_{11} = -\ 3{,}84676,\ log = 0{,}5850951$
0—50° W.	$b = +\ 0{,}74145 = 0{,}8700824_{-1}$	$b_1 = +\ 1{,}92985 = 0{,}2855235$	$b_{11} = -\ 1{,}70757 = 0{,}2323796$
0—50° N.	$const = -\ 5{,}32047 = 0{,}7259500$	$const_1 = +\ 4{,}08319 = 0{,}6109996$	$const_{11} = +\ 2{,}47173 = 0{,}3930011$

Section **VII**

	$A = a \cos\lambda + b \cos^2\lambda + const$	$B = a_1 \cos\lambda + b_1 \cos^2\lambda + const_1$	$C = a_{11} \cos\lambda + b_{11} \cos^2\lambda + const_{11}$
	$a = -\ 2{,}70161,\ log = 0{,}4316226$	$a_1 = +\ 1{,}88795,\ log = 0{,}2759905$	$a_{11} = +\ 0{,}72780,\ log = 0{,}8620121_{-1}$
50—90° W.	$b = +\ 8{,}91021 = 0{,}9498879$	$b_1 = -\ 8{,}71053 = 0.9400448$	$b_{11} = -\ 1{,}62672 = 0{,}2113127$
50—90° N.	$const = +\ 0{,}08850 = 0{,}9469433_{-2}$	$const_1 = +\ 1{,}04923 = 0{,}0208707$	$const_{11} = +\ 0{,}06337 = 0{,}8018837_{-2}$

Section **VIII**

	$A = a \cos\lambda + b \cos^2\lambda + const$	$B = a_1 \cos\lambda + b_1 \cos^2\lambda + const_1$	$C = a_{11} \cos\lambda + b_{11} \cos^2\lambda + const_{11}$
	$a = +\ 0{,}51359,\ log = 0{,}7106166_{-1}$	$a_1 = +\ 0{,}66993,\ log = 0{,}8260294_{-1}$	$a_{11} = -\ 0{,}86043,\ log = 0{,}9347155_{-1}$
50—90° W.	$b = +\ 6{,}25344 = 0{,}7961189$	$b_1 = -\ 5{,}83562 = 0{,}7660874$	$b_{11} = -\ 1{,}09450 = 0{,}0392144$
0—50° N.	$const = +\ 1{,}91968 = 0{,}2832289$	$const_1 = -\ 0{,}43177 = 0{,}6352525_{-1}$	$const_{11} = -\ 0{,}48766 = 0{,}6881171_{-1}$

2. Revised and completed table for Interpolation of the geographical in the Atlantic middle-zones

West	90°	80°	70°	60°	50°	40°	30°	25°	20°	15°	10°	5°
North Pole to lat. 87° 30′												
85°	−0,148	−0,077	−0,876	−1,100	+0,177	−1,456	+2,032	+1,019	+0,460	+0,761	+0,701	− 0,356
80°	−2,215	−1,610	−2,391	−0,983	+1,643	−0,091	+3,451	+4,132	+4,650	+5,113	+5,203	+ 4,286
75°	−3,824	−3,027	−3,263	−0,955	+2,481	+1,754	+5,797	+6,656	+7,301	+7,719	+7,946	+ 7,351
70°	−4,975	−4,328	−3,492	−0,782	+2,691	+4,079	+7,070	+7,845	+8,413	+8,581	+8,930	+ 9,539
65°	−5,814	−5,591	−3,952	−1,130	+2,450	+5,431	+7,303	+7,968	+8,448	+8,460	+8,857	+10,261
60°	−6,488	−6,894	−5,518	−3,465	+1,935	+4,356	+6,529	+7,295	+7,867	+8,118	+8,427	+ 9,159
55°	−6,079	−6,616	−5,648	−5,677	+0,894	+3,556	+5,712	+6,589	+7,224	+7,604	+7,765	+ 7,734
50°	−4,467	−5,825	−5,647	−5,463	−1,139	+2,105	+4,580	+5,528	+6,146	+6,449	+6,394	+ 5,789
45°	−2,590	−3,928	−3,521	−1,841	+1,014	+2,574	+3,517	+3,812	+3,934	+3,861	+3,662	+ 3,163
40°	−2,646	−2,450	−1,795	−0,333	+2,003	+2,212	+2,107	+2,040	+1,965	+1,837	+1,793	+ 1,843
35°	−1,382	−1,175	− 0,469	+0,559	+2,035	+1,282	+0,596	+0,430	+0,427	+0,521	+0,910	+ 1,968
30°	−0,693	−0,104	+0,525	+0,931	+1,329	−0,053	−0,926	−0,996	−0,729	−0,207	+0,821	+ 3,224
25°	−0,644	+0,755	+1,225	+0,907	+0,131	−1,602	−2,381	−2,227	−1,563	−0,491	+1,298	+ 5,258
20°	−0,801	+1,196	+1,474	+0,641	−0,918	−2,611	−3,135	−2,787	−1,861	−0,463	+1,728	+ 6,467
15°	−0,731	+1,013	+1,118	+0,287	−1,175	−2,328	−2,553	−2,203	−1,411	−0,255	+1,500	+ 5,249
10°	−0,434	+0,206	+0,156	−0,155	−0,642	−0,753	−0,635	−0,474	−0,213	+0,132	+0,612	+ 1,605
Equatorial Zone . . .												

Example. Copenhagen $\varphi = 55^\circ\ 41'$ $\lambda = 12^\circ\ 36'$ E.

$60^\circ - 55^\circ\ 41' = 259'$ $12^\circ\ 36' - 10^\circ = 156'$

$n = 0{,}86$ $n = 0{,}52$

φ	λ	$t\varphi, \lambda$
60°	12° 36′	$= 7{,}321 - 0{,}52 \cdot 0{,}608 + 0{,}1248 \cdot 0{,}024 = + 7{,}008$
55°	12° 36′	$= 6{,}032 - 0{,}52 \cdot 0{,}744 - 0{,}1248 \cdot 0{,}030 = + 5{,}641$
50°	12° 36′	$= 4{,}111 - 0{,}52 \cdot 0{,}601 - 0{,}1248 \cdot 0{,}014 = + 3{,}796$

Copenhagen, mean yearly

component (t_φ, λ) of the mean yearly temperature of positions of the Northern Hemisphere.

0°	5°	10°	15°	20°	25°	30°	40°	50°	60°	70°	80°	90°	East
0,000													
− 0,505	+ 0,985	+ 1,923	+ 2,050	+2,140	+ 2,268	+ 2,210	+1,533	+1,004	−0,390	−0,970	−0,820	−0,090	
+ 4,268	+ 7,244	+ 8,795	+ 8,029	+7,626	+ 7,993	+ 7,909	+6,389	+4,167	+0,146	−1,839	−2,470	−1,907	
+ 7,829	+10,700	+12,003	+10,665	+9,907	+10,261	+10,128	+8,399	+5,484	+0,660	−1,886	−3,076	−3,006	
+10,178	+11,355	+11,547	+ 9,959	+8,983	+ 9,073	+ 8,867	+7,563	+4,955	+1,152	−1,111	−2,638	−3,387	
+10,810	+10,201	+ 9,346	+ 7,896	+6,994	+ 6,698	+ 6,336	+5,415	+3,585	+1,231	−0,484	−1,974	−3,141	
+ 9,219	+ 8,188	+ 7,321	+ 6,713	+6,081	+ 5,402	+ 4,744	+3,490	+2,378	+0,507	−0,975	−1,903	−2,358	
+ 7,436	+ 6,741	+ 6,032	+ 5,288	+4,574	+ 3,875	+ 3,240	+2,162	+1,201	−0,148	−1,175	−1,898	−2,456	
+ 5,207	+ 4,671	+ 4,111	+ 3,510	+2,923	+ 2,345	+ 1,791	+0,759	−0,123	−1,235	−1,943	−2,077	−1,407	
+ 2,888	+ 3,012	+ 3,011	+ 2,845	+2,640	+ 2,387	+ 2,110	+1,487	+0,637	+0,518	+0,454	−0,978	−0,767	
+ 1,960	+ 2,241	+ 2,397	+ 2,381	+2,341	+ 2,274	+ 2,187	+1,953	+1,319	+1,984	+2,292	+1,701	+0,188	
+ 2,580	+ 2,548	+ 2,467	+ 2,285	+2,155	+ 2,084	+ 2,054	+2,117	+1,906	+ 2,895	+3,350	+2,633	+0,437	
+ 4,397	+ 3,683	+ 3,056	+ 2,469	+2,060	+ 1,846	+ 1,773	+2,047	+2,367	+3,332	+3,749	+2,997	+0,709	
+ 7,029	+ 5,385	+ 4,005	+ 2,853	+2,035	+ 1,586	+ 1,397	+1,802	+2,678	+3,404	+3,647	+2,939	+1,234	
+ 8,494	+ 6,264	+ 4,413	+ 2,906	+1,842	+ 1,235	+ 0,956	+1,380	+2,568	+2,968	+3,010	+2,436	+1,579	
+ 6,812	+ 4,933	+ 3,378	+ 2,138	+1,243	+ 0,728	+ 0,480	+0,780	+1,765	+1,881	+1,806	+1,464	+1,312	
+ 1,983	+ 1,390	+ 0,901	+ 0,516	+0,238	+ 0,083	− 0,030	+0,002	+0,271	+0,143	+0,033	+0,023	+0,432	
0,000													

$H = 14\ m$

φ	λ	$t\varphi, \lambda$
55° 41′	12° 36′	$= 7{,}008 - 0{,}86 \cdot 1{,}367 + 0{,}0602 \cdot 0{,}478$
$t\varphi, \lambda$		$= + 5{,}861$ °C
$T\varphi$		$= + 2{,}050$ °C
t_h		$= - 0{,}070$ °C

temperature .. .. $= + 7{,}841$ °C

C. Formulæ, coefficients and definitions for the Months.

1. *The series of the normal monthly temperature of any place,* situated in the polar, temperate or tropical zone of the Globe, may be determined by the formula

$$t_m = MV \frac{6\ Q_m}{\Sigma(+\ Q_m)} + M \quad .. \quad .. \quad (8)$$

in which

t_m denotes the normal temperature and calendar order of the month m,
MV the thermo-geographical coefficient of the place,
Q_m the dynamo-cosmical coefficient of the month m,
$\Sigma(+\ Q_m)$ the sum of the positive values of the term Q_m, and
M the mean yearly temperature of the place, observed or calculated.

The terms MV and M may be expressed in any of the thermometrical scales.

2. *The coefficient MV* defines numerically the continentality of the place, as shown in the proposed classification of climates, given under Litr. D of this Codification.

3. *The coefficient MV* is at present determined statistically as an annual function by the formula

$$MV = \frac{\Sigma(+\ t_m^1) - n\ M}{6} \quad .. \quad .. \quad (9)$$

in which

$\Sigma(+\ t_m^1)$ denotes all the observed monthly temperatures $> M$, and
n the number of the months with temperature $> M$.

4. *The amplitude of the movement in any normal series of temperature* is proportional to the coefficient MV and independent of the mean yearly temperature of the place. — The difference of the extreme temperatures in normal series is for the zones of both Hemispheres determined by the formula

$$\text{Amplit.} = \left[\frac{6\ Q_1}{\Sigma(+\ Q_m)} - \frac{6\ Q_{12}}{\Sigma(+\ Q_m)}\right] MV \quad .. \quad .. \quad (10)$$

In *the polar and temperate zones* the coeff. in [ ] is a constant and $= 3{,}_{1954}$; but in *the tropical zone* the coefficient is variable and determined for any latitude by the formula (10) and the varying factors Q_1 and Q_{12}, see Obs. 6—8.

5. *The terms* Q_m *and* $\frac{6\ Q_m}{\Sigma\ (+\ Q_m)}$ are constant in *the polar and temperate zones,* and for the northern and southern Hemisphere determined for each month as follows:

$Q_m =$	Northern Hemisphere		Southern Hemisphere	
January ..	$-\ 1{,}07024$, *log* =	$0{,}0294812$	$+\ 1{,}0000$, *log* =	$0{,}0000000$
February ..	$-\ 0{,}87730$	$0{,}9431481-1$	$+\ 0{,}8197$	$0{,}9136549-1$
March	$-\ 0{,}59733$	$0{,}7762143-1$	$+\ 0{,}5581$	$0{,}7467120-1$
April	$-\ 0{,}07111$	$0{,}8519307-2$	$+\ 0{,}0664$	$0{,}8221681-2$
May	$+\ 0{,}44356$	$0{,}6469524-1$	$-\ 0{,}4144$	$0{,}6174197-1$
June	$+\ 0{,}80177$	$0{,}9040498-1$	$-\ 0{,}7491$	$0{,}8745398-1$
July	$+\ 1{,}00000$	$0{,}0000000$	$-\ 0{,}9344$	$0{,}9705328-1$
August	$+\ 0{,}92181$	$0{,}9646414-1$	$-\ 0{,}8613$	$0{,}9351544-1$
September..	$+\ 0{,}59630$	$0{,}7754648-1$	$-\ 0{,}5572$	$0{,}7460111-1$
October ..	$+\ 0{,}12392$	$0{,}0931414-1$	$-\ 0{,}1158$	$0{,}0637086-1$
November ..	$-\ 0{,}40577$	$0{,}6082799-1$	$+\ 0{,}3792$	$0{,}5788683-1$
December ..	$-\ 0{,}86561$	$0{,}9373223-1$	$+\ 0{,}8088$	$0{,}9078411-1$
	$\Sigma\ (+\ Q_m) = +\ 3{,}88736$, *log* =	$0{,}5896548$	$= +\ 3{,}6322$, *log* =	$0{,}5801698$

$\frac{6\ Q_m}{\Sigma\ (+\ Q_m)} =$	Northern and Southern Hemisphere	
January ..	$\mp\ 1{,}6519$, *log* =	$0{,}2179777$
February ..	$\mp\ 1{,}3541$	$0{,}1316446$
March	$\mp\ 0{,}9220$	$0{,}9647108-1$
April	$\mp\ 0{,}1098$	$0{,}0404272-1$
May	$\pm\ 0{,}6846$	$0{,}8354489-1$
June	$\pm\ 1{,}2375$	$0{,}0925463$
July	$\pm\ 1{,}5435$	$0{,}1884965$
August	$\pm\ 1{,}4228$	$0{,}1531379$
September..	$\pm\ 0{,}9204$	$0{,}9639613-1$
October ..	$\pm\ 0{,}1913$	$0{,}2816379-1$
November ..	$\mp\ 0{,}6263$	$0{,}7967764-1$
December ..	$\mp\ 1{,}3360$	$0{,}1258188$

the upper signs refer to the northern Hemisphere, the lower signs to the southern Hemisphere.

6. In *the tropical zone* the terms Q_m and $\frac{6\ Q_m}{\Sigma\ (+\ Q_m)}$ vary according to the latitude of place. — The fundamental terms Q_m are for this zone determined by the special formula:

$$Q_m = \frac{0{,}0833\ \Sigma\ (sin\ P_m^1) - sin\ P_m^1}{0{,}0833\ \Sigma\ (sin\ P_m^1) - sin\ P_1^1} \quad .. \quad .. \quad (11)$$

in which

P_m^1 denotes $(P_m \mp \varphi)$,
P_1^1 the month in which $(P_m \mp \varphi) = 0$ or the minimum in the series,
$\mp \varphi$ respectively the northern or southern latitude of the place, and
P_m the rectified, retarded altitude of the sun over the equatorial plan, referred to the chronological centre of the month in question.

P_m is determined for each month as follows:

January ..	25° 6′ S.	July..	23° 21′ N.
February ..	20° 21′ S.	August ..	21° 25′ N.
March	13° 42′ S.	Septemb. ..	13° 40′ N.
April	1° 37′ S.	October ..	2° 49′ N.
May	10° 7′ N.	Novemb. ..	9° 15′ S.
June	18° 31′ N.	Decemb. ..	20° 4′ S.

the sign of P_m is + in positions N., and — in positions S., or the reverse of the lat. in the formula (11)

$0{,}0833\ \Sigma\ (sin\ P_m^1)$ = the mean of the series of $sin\ P_m^1$, all taken positive.

7. *The thermal order of the Months.* In any series of temperature the month of the highest temperature is marked 1, and that of the lowest temperature 12; the other months in the series accordingly.

8. *The normal order of the Months in respect to temperature* is for all zones given by the function Q_m; in tropical places also by the position $(P_m \mp \varphi)$, as shown above, Obs. 6.

The thermal order of the months is according to this definition and in the normal series as follows:

	January	February	March	April	May	June	July	August	Septbr.	Octob.	Novbr.	Decbr.
in the northern polar and temperate zone ..	12	11	9	7	5	3	1	2	4	6	8	10
under the Equator	12	9	6	1	4	7	11	10	5	2	3	8
in the southern temperate and polar zone ..	1	2	4	6	8	10	12	11	9	7	5	3

9. *The total displacement* is the difference for the year of the observed and the normal order in the series of temperature.

Example. *Barbadoes*, lat. 13° 4′ N.

	Jan.	Febr.	March	April	May	June	July	August	Septbr.	Octbr.	Novbr.	Decbr.	total displacem.
observed order	12	11	9	7	2	1	5	3	4	6	8	10	
normal order	12	11	9	7	2	3	6	4	1	5	8	10	
displacement ..	0	0	0	0	0	2	1	1	3	1	0	0	8

10. *The meteorological series*

$$\Sigma\,(\pm\,\Delta_m) = \Delta_1 + \Delta_2 + \Delta_3 + \ldots\ldots \Delta_{12} = 0 \quad .. \quad .. \quad (12)$$

is for any place determined by the difference of the observed and the normal series of temperature.

The observed series of temperature of the above place, *Barbadoes*, is analysed as follows:

		Jan.	Febr.	March	April	May	June	July	Aug.	Septb.	Octob.	Novb.	Decbr.	Year	
observed series ..	t_m^1	78,9	79,0	79,8	80,8	81,9	81,9	81,6	81,8	81,8	81,4	80,8	79,6	80,78	°F
normal series ..	t_m	78,98	79,35	79,91	81,08	82,13	81,78	81,32	81,50	82,25	81,43	80,31	79,39	80,78	
difference ..	Δ_m	−0,08	−0,35	−0,11	−0,28	−0,33	+0,12	+0,28	+0,30	−0,45	−0,03	+0,49	+0,21	±1,40	

11. *The meteorological series* forms the monthly component of the normal series of temperature, and represents the combined thermal effect in each month of either periodically recurrent or fluctuating meteorological elements. The meteorological series may be divided in two distinct categories:

continuous series, in which the differences arrange themselves in two consecutive groups, one consisting of positive and one of negative terms; this order is most probably the result of prevalent periodicity in the meteorological phenomena; and

irregular series, in which the signs of the terms follow each other in no distinct order, most probably the result of the action of undecided and varying meteorological factors.

The yearly repeated analysis of the meteorological series is required in order to decide with certainty the category of the series.

The following are examples of both categories:

continuous series		*irregular series*	
Bermuda (Atlant. Ocean)	+ + − − − − 0 + + + + +	Barbadoes (West-Indies) ..	− − − − − + + + − − + +
Cochin (Monsoon distr., India)	+ + + + − − − − − − − + +	Rome (Italy)	+ + + − − − + + + + − −
Olekminsk (Eastern Siberia) ..	− + + + + + + − − − − −	Brisbane (Eastern Australia)	− − + + + − − + + + + −

D. Proposed numerical classification of climates.

MV	Definition of climate	Class of climate
0,00 to 3,000 °C	tropical and extreme insular climate	I
3,00 - 4,000	extreme coast climate	II
4,00 - 6,000	normal coast climate	III
6,00 - 9,000	normal continental climate	IV
9,00 - 11,000	central continental climate	V
11,00 - 15,000	extreme continental climate	VI
beyond 15,000	polar continental climate	VII

E. General remarks. — Conclusion.

The methods and fundamental numericals, employed in the construction of the codified formulæ and coefficients, have been fully recorded in the „Thermo-geographical studies“, as well as the discussion of the formulæ and the severe and extended proofs to which the same have been subjected. — The final results of the entire series of researches may be given in the conclusion:

that the codified system of thermo-geographical formulæ, including corrections for certain extreme regions, produces results, approximating the means of many years of actual observations, and

that the same opens a new field for analytical investigations in the physical geography, based upon the temperature as the standard-unit for the measurement and comparison of geo-physical and meteorological elements.

APPENDICES.

COPENHAGEN. — AXEL E. AAMODT.

TABLE I.

SHOWING THE NORMAL MEAN YEARLY TEMPERATURE OF THE PARALLELS, AND THE MEAN LATITUDE OF ISOTHERMALS FOR THE YEAR, ACCORDING TO DIFFERENT AUTHORS AND EQUATIONS.

The Equations referred to in this table are the following:

I. Littrow, 1865 (?), general equation.

$$T\varphi = 17{,}13 \cos 2\varphi + 13{,}66.$$

II. v. Freeden, 1863, according to Doves table, 1852.

Northern Hemisphere $T\varphi = 17{,}791 \cos \varphi + 28{,}181 \cos \varphi^2 - 17{,}391.$

III. The Author, 1890, according to interpolations of Andrees System of Isothermals for the Year, 1890.

N. H. $T\varphi = 41{,}747 \cos \varphi + 13{,}033 \cos \varphi^2 - 25{,}119.$

S. H. $T\varphi = 23{,}019 \cos \varphi + 18{,}716 \cos \varphi^2 - 14{,}900.$

IV. The Author, 1892, according to numericals from Dove, J. Hann & Spitaler, Mohn and the Equations II and III.

N. H. $T\varphi = 35{,}6457 \cos \varphi + 16{,}1857 \cos \varphi^2 - 23{,}0668.$

S. H. $T\varphi = 10{,}4694 \cos \varphi + 28{,}1328 \cos \varphi^2 - 11{,}8438.$

V. The Author, 1892, according to numericals from Dove, J. Hann & Spitaler, Mohn and the Equation IV.

N. H. $T\varphi = 31{,}7544 \cos \varphi + 18{,}6395 \cos \varphi^2 - 21{,}7620.$

S. H. $T\varphi = 10{,}0371 \cos \varphi + 28{,}3073 \cos \varphi^2 - 11{,}6545.$

φ denotes the latitude of the Parallel, and

$T\varphi$ the normal temperature of the Parallel in degrees centigrade.

LATITUDE OF PARALLEL $= \varphi$	THE PARALLELS NORMAL TEMPERATURE FOR THE YEAR, ACCORDING TO THE AUTHORS						THE PARALLELS NORMAL TEMPERATURE FOR THE YEAR, ACCORDING TO THE EQUATIONS			
	Dove, 1852		J. Hann and Spitaler, 1886		Mohn, 1887		I GENERAL EQUATION	II	III	
	N. H.	S. H.	N. H.	S. H.	N. H.	S. H.		N. H.	N. H.	S. H.
	1	2	3	4	5	6	7	8	9	10
90°	—16,500°C	-	—20,00°C	— 9,30°C	—20,00°C	—10,00°C	— 3,47°C	—17,391°C	—25,119°C	—14,900°C
85°	-	-	-	-	-	-	— 3,21	-	—21,381	—12,752
80°	—14,000	-	—16,80	— 8,40	—16,50	— 8,00	— 2,44	—13,453	—17,477	—10,339
75°	-	-	—13,30	-	-	-	— 1,17	-	—13,441	— 7,691
70°	— 8,875	-	— 9,90	— 4,90	— 9,90	— 4,80	+ 0,54	— 7,998	— 9,316	— 4,838
65°	— 5,250	-	— 4,30	-	— 4,30	— 3,00	2,65	— 4,840	— 5,148	— 1,829
60°	— 1,000	-	— 0,80	+ 0,20	— 0,80	— 0,70	5,09	— 1,450	— 0,988	+ 1,289
55°	-	-	+ 2,30	3,20	-	-	7,80	-	+ 3,114	4,460
50°	+ 5,375	-	5,60	5,90	+ 5,60	+ 5,90	10,69	+ 5,689	7,100	7,629
45°	-	-	9,60	8,90	-	-	13,66	-	10,918	10,735
40°	13,625	12,500	14,00	11,80	14,00	11,80	16,63	12,775	14,509	13,717
35°	-	-	17,10	15,20	-	-	19,52	-	17,823	16,515
30°	21,000	19,375	20,30	18,50	20,30	18,50	22,23	19,153	20,810	19,072
25°	-	-	23,70	20,90	-	-	24,67	-	23,422	21,335
20°	25,250	23,375	25,60	22,70	25,70	22,70	26,78	24,210	25,618	23,258
15°	-	-	26,30	24,20	-	-	28,49	-	27,366	24,797
10°	26,650	25,500	26,40	25,00	26,40	25,00	29,76	27,464	28,634	25,942
5°	-	-	26,10	25,50	-	-	30,53	-	29,403	26,605
0°	26,500	26,500	25,90	25,90	25,90	25,90	30,79	28,581	29,661	26,835

FORMULÆ OF REDUCTION OF MEAN TEMPERATURE TO LATITUDE (EQUATION V).

$$N.\ H. \quad \cos\varphi = 0{,}2316\ \sqrt{T\varphi + 35{,}2861} - 0{,}8518$$

$$\log 0{,}2316 = 0{,}3647828 - 1.$$

$$S.\ H. \quad \cos\varphi = 0{,}18795\ \sqrt{T\varphi + 12{,}5442} - 0{,}1773$$

$$\log 0{,}18795 = 0{,}2740505 - 1.$$

MEAN LATITUDE OF ISOTHERMALS FOR THE YEAR

ISOTHERMALS	ACCORDING TO THE EQUATION V	
	N. H.	S. H.
—10°C	71° 46′	82° 58′
— 5°	64° 59′	70° 11′
0°	58° 24′	60° 46′
+ 5°	51° 48′	52° 25′
10°	45° 1′	44° 21′
15°	37° 45′	36° 0′
20°	29° 30′	26° 30′
+25°	18° 49′	13° 0′

THE PARALLELS NORMAL TEMPERATURE FOR THE YEAR, ACCORDING TO MEANS AND EQUATIONS								LATITUDE OF PARALLEL $= \varphi$
MEANS OF		EQUATION IV		MEANS OF		EQUATION V		
1, 3, 5, 8, 9 N. H.	2, 4, 6, 10 S. H.	N. H.	S. H.	11, 13 N. H.	12, 14 S. H.	N. H.	S. H.	
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	
$-19{,}802$°C	$-11{,}400$°C	$-23{,}0668$°C	$-11{,}8438$°C	$-21{,}4344$°C	$-11{,}6219$°C	$-21{,}7620$°C	$-11{,}6545$°C	90°
-	-	-	-	-	-	$-18{,}8528$	$-10{,}5647$	85°
$-15{,}646$	$-\ 8{,}913$	$-16{,}3889$	$-\ 9{,}1775$	$-16{,}0175$	$-\ 9{,}0452$	$-15{,}6858$	$-\ 9{,}0580$	80°
-	-	-	-	-	-	$-12{,}2947$	$-\ 7{,}1605$	75°
$-\ 9{,}198$	$-\ 4{,}846$	$-\ 8{,}9818$	$-\ 4{,}9722$	$-\ 9{,}0899$	$-\ 4{,}9091$	$-\ 8{,}7209$	$-\ 4{,}9103$	70°
$-\ 4{,}768$	$-\ 2{,}415$	$-\ 5{,}1114$	$-\ 2{,}3945$	$-\ 4{,}9397$	$-\ 2{,}4048$	$-\ 5{,}0129$	$-\ 2{,}3567$	65°
$-\ 1{,}008$	$+\ 0{,}262$	$-\ 1{,}1976$	$+\ 0{,}4291$	$-\ 1{,}1028$	$+\ 0{,}3435$	$-\ 1{,}2249$	$+\ 0{,}4409$	60°
-	-	-	-	-	-	$+\ 2{,}5838$	$3{,}4153$	55°
$+\ 5{,}873$	$6{,}476$	$+\ 6{,}5334$	$6{,}5096$	$+\ 6{,}2032$	$6{,}4928$	$6{,}3507$	$6{,}4931$	50°
-	-	-	-	-	-	$10{,}0115$	$9{,}5965$	45°
$13{,}782$	$12{,}454$	$13{,}7376$	$12{,}6852$	$13{,}7598$	$12{,}5696$	$13{,}5014$	$12{,}6458$	40°
-	-	-	-	-	-	$16{,}7570$	$15{,}5619$	35°
$20{,}313$	$18{,}862$	$19{,}9426$	$18{,}3226$	$20{,}1278$	$18{,}5923$	$19{,}7177$	$18{,}2684$	30°
-	-	-	-	-	-	$22{,}3277$	$20{,}6937$	25°
$25{,}276$	$23{,}008$	$24{,}7162$	$22{,}8361$	$24{,}9961$	$22{,}9221$	$24{,}5365$	$22{,}7733$	20°
-	-	-	-	-	-	$26{,}3013$	$24{,}4517$	15°
$27{,}110$	$25{,}361$	$27{,}6543$	$25{,}7510$	$27{,}3822$	$25{,}5560$	$27{,}5874$	$25{,}6839$	10°
-	-	-	-	-	-	$28{,}3695$	$26{,}4367$	5°
$27{,}308$	$26{,}284$	$28{,}7646$	$26{,}7584$	$28{,}0363$	$26{,}5212$	$28{,}6319$	$26{,}6899$	0°

Obs. In accordance with arguments, stated in § 4, the introduction of an equatorial zone from the lat. 10° N. to 10° S., with a uniform mean yearly temperature $= +27{,}233$°C, has been proposed as a correction of the calculated temperature of this part of the tropical zone.

TABLE II.

SHOWING THE INTERPOLATED MEAN YEARLY TEMPERATURE AND THE ANNUAL THERMO-GEOGRAPHICAL COMPONENT OF DIFFERENT GEOGRAPHICAL POSITIONS IN THE ATLANTIC MIDDLE-ZONES OF THE NORTHERN HEMISPHERE.

φ denotes the true, and φ_1 the »improved« latitude of a geographical position or place,

$T\varphi$ the normal yearly temperature of a parallel or place of the latitude $= \varphi$, as calculated from the equation V (Tab. I), and

M the mean yearly temperature of a geographical position, as determined by interpolation on the system of Isothermals for the Year, constructed and published under the authority of Prof., Dr. Jul. Hann, 1887. For corrections applied, see Tab. III and § 9.

$t\varphi,\lambda$ or »the annual thermo-geographical component« is equal to the difference of the local mean yearly temperature at sea-level of a place and the normal yearly temperature of the corresponding parallel or latitude.

cos φ_1 is calculated from the formula of reduction, Tab. I; *arc cos* φ_1 signifies the »improved« latitude corresponding to the mean yearly temperature of the place.

WEST	90°	80°	70°	60°	50°	40°	30°	25°	20°	15°	10°
NORTHERN HEMISPHERE.											
75° $M=$	−16,583	−15,756	−14,169	−12,403	−11,367	−10,314	− 7,400	− 5,733	− 4,569	− 4,154	− 4,000
$T\varphi=-12{,}2947$°C $t\varphi,\lambda=$	− 4,288	− 3,461	− 1,874	− 0,108	+ 0,928	+ 1,981	+ 4,895	+ 6,562	+ 7,726	+ 8,141	+ 8,295
$\cos\varphi=$ 0,2588 $\cos\varphi_1=$	0,1499	0,1718	0,2126	0,2562	0,2810	0,3057	0,3713	0,4079	0,4319	0,4406	0,4438
70° $M=$	−13,375	−12,739	−12,671	− 7,681	− 5,688	− 4,842	− 0,942	− 0,342	− 0,009	− 0,109	− 0,145
$T\varphi=-8{,}7209$°C $t\varphi,\lambda=$	− 4,654	− 4,018	− 3,950	+ 1,040	+ 3,033	+ 3,879	+ 7,779	+ 8,379	+ 8,712	+ 8,612	+ 8,576
$\cos\varphi=$ 0,3420 $\cos\varphi_1=$	0,2324	0,2480	0,2497	0,3652	0,4083	0,4262	0,5056	0,5174	0,5239	0,5220	0,5213
65° $M=$	−10,591	−10,324	− 8,681	− 4,187	− 2,843	+ 1,107	+ 2,876	+ 3,449	+ 3,526	+ 3,317	+ 3,279
$T\varphi=-5{,}0129$°C $t\varphi,\lambda=$	− 5,578	− 5,311	− 3,668	+ 0,826	+ 2,170	+ 6,120	+ 7,889	+ 8,462	+ 8,539	+ 8,330	+ 8,292
$\cos\varphi=$ 0,4226 $\cos\varphi_1=$	0,2992	0,3054	0,3429	0,4399	0,4675	0,5455	0,5791	0,5898	0,5912	0,5873	0,5866
60° $M=$	− 7,963	− 8,473	− 7,147	− 3,638	+ 0,402	+ 2,987	+ 5,329	+ 6,151	+ 6,452	+ 6,602	+ 6,722
$T\varphi=-1{,}2249$°C $t\varphi,\lambda=$	− 6,738	− 7,248	− 5,922	− 2,413	+ 1,626	+ 4,211	+ 6,553	+ 7,375	+ 7,676	+ 7,826	+ 7,976
$\cos\varphi=$ 0,5000 $\cos\varphi_1=$	0,3589	0,3476	0,3769	0,4512	0,5319	0,5811	0,6243	0,6392	0,6446	0,6473	0,6494
55° $M=$	− 3,746	− 4,746	− 4,007	− 2,082	+ 3,024	+ 5,588	+ 8,107	+ 8,699	+ 9,112	+ 9,255	+ 9,349
$T\varphi=+2{,}5838$°C $t\varphi,\lambda=$	− 6,329	− 7,329	− 6,590	− 4,665	+ 0,440	+ 3,004	+ 5,523	+ 6,115	+ 6,528	+ 6,671	+ 6,765
$\cos\varphi=$ 0,5736 $\cos\varphi_1=$	0,4490	0,4282	0,4436	0,4829	0,5818	0,6290	0,6740	0,6843	0,6915	0,6940	0,6957
50° $M=$	+ 1,829	+ 1,343	+ 1,266	+ 2,629	+ 5,370	+ 9,629	+11,462	+11,879	+12,064	+12,462	+12,629
$T\varphi=+6{,}3507$°C $t\varphi,\lambda=$	− 4,523	− 5,009	− 5,086	− 3,723	− 0,982	+ 3,277	+ 5,110	+ 5,527	+ 5,712	+ 6,110	+ 6,277
$\cos\varphi=$ 0,6428 $\cos\varphi_1=$	0,5593	0,5500	0,5486	0,5744	0,6251	0,7005	0,7319	0,7389	0,7420	0,7487	0,7515
45° $M=$	+ 7,872	+ 5,851	+ 6,031	+ 6,860	+10,460	+12,460	+14,103	+14,460	+14,270	+14,074	+13,228
$T\varphi=+10{,}0115$°C $t\varphi,\lambda=$	− 2,140	− 4,161	− 3,981	− 3,152	+ 0,448	+ 2,448	+ 4,091	+ 4,448	+ 4,258	+ 4,062	+ 3,216
$\cos\varphi=$ 0,7071 $\cos\varphi_1=$	0,6663	0,6338	0,6370	0,6519	0,7148	0,7487	0,7760	0,7819	0,7787	0,7755	0,7615
40° $M=$	+10,401	+11,219	+10,901	+12,674	+14,801	+16,142	+15,901	+15,590	+15,290	+14,734	+14,555
$T\varphi=+13{,}5014$°C $t\varphi,\lambda=$	− 3,101	− 2,283	− 2,601	− 0,828	+ 1,300	+ 2,641	+ 2,400	+ 2,089	+ 1,789	+ 1,233	+ 1,054
$\cos\varphi=$ 0,7660 $\cos\varphi_1=$	0,7138	0,7278	0,7223	0,7523	0,7875	0,8093	0,8054	0,8060	0,7954	0,7864	0,7834
35° $M=$	+15,480	+15,157	+17,480	+18,200	+18,694	+19,028	+18,013	+17,221	+17,000	+16,743	+16,647
$T\varphi=+16{,}7570$°C $t\varphi,\lambda=$	− 1,277	− 1,600	+ 0,723	+ 1,443	+ 1,937	+ 2,271	+ 1,256	+ 0,464	+ 0,243	− 0,014	− 0,110
$\cos\varphi=$ 0,8192 $\cos\varphi_1=$	0,7985	0,7933	0,8307	0,8422	0,8500	0,8552	0,8392	0,8266	0,8231	0,8189	0,8174
30° $M=$	+19,290	19,899	21,290	21,635	21,061	20,462	19,623	18,964	18,695	18,890	20,090
$T\varphi=+19{,}7177$°C $t\varphi,\lambda=$	− 0,428	+ 0,182	+ 1,573	+ 1,918	+ 1,344	+ 0,745	− 0,095	− 0,754	− 1,023	− 0,828	+ 0,373
$\cos\varphi=$ 0,8660 $\cos\varphi_1=$	0,8593	0,8689	0,8904	0,8957	0,8869	0,8776	0,8646	0,8542	0,8500	0,8530	0,8718
25° $M=$	+21,617	22,617	22,217	23,050	22,002	20,992	20,196	20,105	20,375	21,179	23,344
$T\varphi=+22{,}3277$°C $t\varphi,\lambda=$	− 0,711	+ 0,289	− 0,111	+ 0,722	− 0,326	− 1,336	− 2,132	− 2,223	− 1,953	− 1,149	+ 1,016
$\cos\varphi=$ 0,9063 $\cos\varphi_1=$	0,8954	0,9107	0,9046	0,9172	0,9013	0,8858	0,8734	0,8721	0,8763	0,8887	0,9217

5°	0°	5°	10°	15°	20°	25°	30°	40°	50°	60°	70°	80°	90° EAST
— 3,923	— 3,863	— 3,400	— 2,697	— 3,225	— 3,488	— 3,485	— 3,469	— 4,216	— 6,234	—10,307	—13,000	—15,000	-
+ 8,372	+ 8,432	+ 8,895	+ 9,598	+ 9,070	+ 8,807	+ 8,810	+ 8,826	+ 8,079	+ 6,061	+ 1,988	+ 0,705	— 2,705	-
0,4454	0,4466	0,4561	0,4705	0,4597	0,4543	0,4544	0,4547	0,4393	0,3967	0,3058	0 2417	0,1914	-
+ 0,158	+ 1,586	+ 3,158	+ 4,513	+ 3,158	-	+ 1,158	+ 1,158	— 0,185	— 3,810	— 8,051	—10,120	—11,478	—12,161
+ 8,879	+10,307	+11,879	+13,234	+11,879	-	+ 9,879	+ 9,879	+ 8,536	+ 4,911	+ 0,670	— 1,399	— 2,757	— 3,440
0,5272	0,5547	0,5844	0,6094	0,5844	-	0,5465	0,5465	0,5205	0,4477	0,3570	0,3102	0,2784	0,2621
+ 4,590	+ 6,414	+ 7,088	+ 4,545	+ 2,757	+ 1,302	+ 1,557	+ 1,357	+ 0,757	— 1,522	— 3,710	— 5,243	— 6,781	— 8,243
+ 9,603	+11,427	+12,101	+ 9,558	+ 7,770	+ 6,315	+ 6,570	+ 6,370	+ 5,770	+ 3,491	+ 1,303	— 0,230	— 1,768	— 3,230
0,6109	0,6439	0,6560	0,6100	0,5768	0,5492	0,5541	0,5503	0,5388	0,4941	0,4496	0,4178	0,3849	0,3527
+ 6,922	+ 7,566	+ 7,191	+ 5,578	+ 3,965	+ 4,764	+ 4,122	+ 3,512	+ 2,178	+ 1,122	— 0,779	— 2,359	— 3,064	— 3,279
+ 8,146	+ 8,790	+ 8,415	+ 6,802	+ 5,189	+ 5,988	+ 5,346	+ 4,736	+ 3,402	+ 2,346	+ 0,446	— 1,134	— 1,839	— 2,054
0,6530	0,6644	0,6578	0,6288	0,5993	0,6140	0,6022	0,5909	0,5659	0,5458	0,5088	0,4773	0,4630	0,4586
+ 9,669	+ 9,581	+ 9,056	+ 8,242	+ 7,811	+ 7,255	+ 6,740	+ 5,965	+ 4,415	+ 3,669	+ 2,958	+ 2,255	— 0,032	— 0,146
+ 7,085	+ 6,997	+ 6,472	+ 5,658	+ 5,227	+ 4,671	+ 4,156	+ 3,381	+ 1,831	+ 1,085	+ 0,374	— 0,330	— 2,615	— 2,729
0,7012	0,6997	0,6906	0,6763	0,6688	0,6589	0,6498	0,6358	0,6076	0,5938	0,5806	0,5674	0,5235	0,5213
+12,063	+11,589	+11,306	+10,290	+10,029	+ 9,629	+ 9,129	+ 8,129	+ 7,629	+ 6,318	+ 5,398	+ 4,447	+ 4,167	+ 5,148
+ 5,711	+ 5,237	+ 4,954	+ 3,938	+ 3,677	+ 3,277	+ 2,777	+ 1,777	+ 1,277	— 0,034	— 0,954	— 1,904	— 2,185	— 1,204
0,7420	0,7340	0,7292	0,7119	0,7074	0,7005	0,6918	0,6744	0,6655	0,6388	0,6256	0,6082	0,6031	0,6210
+13,769	+13,560	+13,127	+14,005	+14,460	+11,845	+11,571	+11,460	+12,016	+10,220	+ 9,904	+ 9,460	+10,460	+ 9,031
+ 3,757	+ 3,548	+ 3,115	+ 3,993	+ 4,448	+ 1,833	+ 1,559	+ 1,448	+ 2,004	+ 0,208	— 0,108	— 0,552	+ 0,448	— 0,981
0,7705	0,7670	0,7598	0,7744	0,7819	0,7383	0,7337	0,7319	0,7412	0,7107	0,7053	0,6976	0,7148	0,6901
+15,886	+16,544	+16,330	+16,508	+16,201	+16,792	+14,845	+15,401	+15,173	+13,934	+14,686	+16,016	+15,687	+13,765
+ 2,385	+ 3,043	+ 2,829	+ 3,007	+ 2,700	+ 3,291	+ 1,344	+ 1,900	+ 1,672	+ 0,433	+ 1,185	+ 2,515	+ 2,186	+ 0,264
0,8051	0,8157	0,8123	0,8152	0,8102	0,8197	0,7882	0,7972	0,7935	0,7732	0,7856	0,8072	0,8019	0,7704
+17,480	+18,480	+19,480	+19,480	+18,600	+18,813	+18,580	+18,438	+20,636	+19,480	+19,337	+20,480	+18,680	+17,147
+ 0,723	+ 1,723	+ 2,723	+ 2,723	+ 1,843	+ 2,056	+ 1,823	+ 1,681	+ 3,879	+ 2,723	+ 2,580	+ 3,723	+ 1,923	+ 0,390
0,8307	0,8466	0,8623	0,8623	0,8485	0,8518	0,8482	0,8459	0,8803	0,8623	0,8601	0,8779	0,8498	0,8254
22,290	24,120	24,540	23,290	21,290	20,690	20,624	20,467	22,690	22,957	21,654	24,623	23,290	20,179
+ 2,573	+ 4,403	+ 4,823	+ 3,573	+ 1,573	+ 0,973	+ 0,907	+ 0,750	+ 2,973	+ 3,240	+ 1,937	+ 4,906	+ 3,573	+ 0,462
0,9057	0,9334	0,9398	0,9209	0,8904	0,8811	0,8801	0,8776	0,9118	0,9159	0,8960	0,9410	0,9209	0,8732
26,617	28,617	28,617	28,061	26,617	24,617	23,459	23,177	24,117	24,617	24,617	26,617	25,617	23,617
+ 4,289	+ 6,289	+ 6,289	+ 5,733	+ 4,289	+ 2,289	+ 1,131	+ 0,849	+ 1,789	+ 2,289	+ 2,289	+ 4,289	+ 3,289	+ 1,289
0,9706	0,9998	0,9998	0,9913	0,9706	0,9409	0,9235	0,9192	0,9334	0,9409	0,9409	0,9706	0,9558	0,9259

TABLE III.

SHOWING THE INTERPOLATED MEAN YEARLY TEMPERATURS AND THE ANNUAL THERMO-GEOGRAPHICAL COMPONENT OF DIFFERENT GEOGRAPHICAL POSITIONS IN THE PACIFIC MIDDLE-ZONES OF THE NORTHERN HEMISPHERE.

φ denotes the true, and φ_1 the »improved« latitude of a geographical position or place,

$T\varphi$ the normal yearly temperature of a parallel or place of the latitude $= \varphi$, as calculated from the equation V (Tab. I), and

M the mean yearly temperature of a geographical position, as determined by interpolation on the system of Isothermals for the Year, constructed and published under the authority of Prof., Dr. Jul. Hann, 1887.

$t\varphi,\lambda$ or „the annual thermo-geographical component“, is equal to difference of the local mean yearly temperature at sea-level of a place and the normal yearly temperature of the corresponding parallel or latitude.

NORTHERN HEMISPHERE	WEST OF GREENWICH MERIDIAN											
	180°	**170°**	**160°**	**150°**	**140°**	**130°**	**125°**	**120°**	**115°**	**110°**	**100°**	**90°**
75° $M=$	−15,000	-	-	-	-	-	-	−16,170	−16,426	−16,639	−16,733	−16,583
$T\varphi=-12{,}2947$°C $t\varphi,\lambda=$	− 2,705	-	-	-	-	-	-	− 3,875	− 4,131	− 4,344	− 4,438	− 4,288
70° $M=$	−11,929	−11,842	−11,709	−11,842	−12,342	−13,036	−13,221	−13,413	−13,583	−13,673	−13,699	−13,375
$T\varphi=-\ 8{,}7209$°C $t\varphi,\lambda=$	− 3,208	− 3,121	− 2,988	− 3,121	− 3,621	− 4,315	− 4,500	− 4,692	− 4,862	− 4,951	− 4,978	− 4,654
65° $M=$	− 6,243	− 5,243	− 6,523	− 5,529	− 5,243	− 6,368	− 7,243	− 7,910	− 8,547	− 9,243	−10,243	−10,591
$T\varphi=-\ 5{,}0129$°C $t\varphi,\lambda=$	− 1,230	− 0,230	− 1,503	− 0,516	− 0,230	− 1,355	− 2,230	− 2,897	− 3,534	− 4,230	− 5,230	− 5,578
60° $M=$	− 0,279	− 0,679	− 1,479	+ 3,722	+ 4,294	+ 0,742	− 0,850	− 1,739	− 2,824	− 3,879	− 6,279	− 7,963
$T\varphi=-\ 1{,}2249$°C $t\varphi,\lambda=$	+ 0,946	+ 0,546	− 0,254	+ 4,946	+ 5,518	+ 1,946	+ 0,375	− 0,514	− 1,599	− 2,654	− 5,054	− 6,738
55° $M=$	+ 3,667	+ 2,619	+ 5,172	+ 7,428	+ 7,541	+ 7,071	+ 5,588	+ 3,528	+ 1,880	+ 0,255	− 1,213	− 3,746
$T\varphi=+\ 2{,}5838$°C $t\varphi,\lambda=$	+ 1,083	+ 0,035	+ 2,588	+ 4,844	+ 4,957	+ 4,487	+ 3,004	+ 0,944	− 0,704	− 2,329	− 3,796	− 6,329
50° $M=$	+ 6,629	+ 8,629	+ 9,740	+10,020	+ 0,696	+ 9,522	+ 9,313	+ 9,851	+ 9,814	+ 7,398	+ 3,144	+ 1,829
$T\varphi=+\ 6{,}3507$°C $t\varphi,\lambda=$	+ 0,277	+ 2,277	+ 3,388	+ 3,668	+ 3,344	+ 3,170	+ 2,961	+ 3,499	+ 3,462	+ 1,046	− 3,208	− 4,523
45° $M=$	+10,556	+11,849	+12,355	+12,278	+11,571	+10,400	+10,460	+14,460	+14,460	+12,036	+ 8,460	+ 7,872
$T\varphi=+10{,}0115$°C $t\varphi,\lambda=$	+ 0,544	+ 1,837	+ 2,343	+ 2,266	+ 1,559	+ 0,388	+ 0,448	+ 4,448	+ 4,448	+ 2,024	− 1,552	− 2,140
40° $M=$	+12,401	+12,992	+13,193	+13,401	+12,610	+10,892	+10,370	+17,801	+17,187	+14,901	+13,401	+10,401
$T\varphi=+13{,}5014$°C $t\varphi,\lambda=$	− 1,100	− 0,509	− 0,308	− 0,100	− 0,891	− 2,609	− 3,131	+ 4,299	+ 3,685	+ 1,399	− 0,100	− 3,100
35° $M=$	+15,080	+15,480	+15,480	+15,306	+14,480	+12,553	+10,480	+15,480	+22,377	+18,480	+17,480	+15,480
$T\varphi=+16{,}7570$°C $t\varphi,\lambda=$	− 1,677	− 1,277	− 1,277	− 1,451	− 2,277	− 4,204	− 6,277	− 1,277	+ 5,620	+ 1,723	+ 0,723	− 1,277
30° $M=$	+18,401	+18,768	+18,576	+17,878	+16,444	+14,346	+13,290	+13,290	+19,290	+22,290	+20,957	+19,290
$T\varphi=+19{,}7177$°C $t\varphi,\lambda=$	− 1,317	− 0,950	− 1,142	− 1,840	− 3,274	− 5,372	− 6,428	− 6,428	− 0,428	+ 2,573	+ 1,240	− 0,428
25° $M=$	+21,717	+21,317	+20,617	+19,405	+18,217	+17,002	+15,867	+15,867	+18,617	+24,617	+24,217	+21,617
$T\varphi=+22{,}3277$°C $t\varphi,\lambda=$	− 0,611	− 1,011	− 1,711	− 2,923	− 4,111	− 5,326	− 6,461	− 6,461	− 3,711	+ 2,289	+ 1,889	− 0,711

EAST OF GREENWICH MERIDIAN

90°	100°	110°	120°	130°	140°	150°	160°	170°	180°
-	-	-	-	-	-	-	-	-	−15,000
-	-	-	-	-	-	-	-	-	− 2,705
−12,161	−12,475	−12,975	−14,011	−15,842	−14,580	−13,242	−12,307	−11,467	−11,929
− 3,440	− 3,754	− 4,254	− 5,290	− 7,121	− 5,859	− 4,521	− 3,586	− 2,746	− 3,208
− 8,243	− 9,243	−10,313	−11,243	−13,243	−12,180	−10,243	− 8,879	− 7,843	− 6,243
− 3,230	− 4,230	− 5,300	− 6,230	− 8,230	− 7,167	− 5,230	− 3,866	− 2,830	− 1,230
− 3,279	− 3,979	− 6,279	− 7,817	− 8,546	− 7,546	− 5,879	− 5,067	− 2,279	− 0,279
− 2,054	− 2,754	− 5,054	− 6,592	− 7,321	− 6,321	− 4,654	− 3,842	− 1,054	+ 0,946
− 0,146	+ 1,416	− 1,146	− 3,096	− 3,746	− 2,930	− 1,746	+ 0,255	+ 3,188	+ 3,667
− 2,729	− 1,168	− 3,729	− 5,679	− 6,329	− 5,513	− 4,329	− 2,329	+ 0,604	+ 1,083
+ 5,148	+ 4,851	+ 1,829	+ 0,629	+ 0,020	+ 0,629	+ 1,696	+ 5,997	+ 7,415	+ 6,629
− 1,204	− 1,501	− 4,523	− 5,723	− 6,332	− 5,723	− 4,656	− 0,355	+ 1,063	+ 0,277
+ 9,031	+ 7,603	+ 5,299	+ 3,768	+ 3,674	+ 5,127	+ 6,460	+ 9,460	+11,127	+10,556
− 0,981	− 2,409	− 4,713	− 6,244	− 6,338	− 4,885	− 3,552	− 0,552	+ 1,115	+ 0,544
+13,765	+11,984	+ 9,401	+ 9,401	+ 7,863	+11,401	+12,553	+12,733	+12,733	+12,401
+ 0,264	− 1,518	− 4,101	− 4,101	− 5,639	− 2,101	− 0,949	− 9,769	− 0,769	− 1,101
+17,147	+16,096	+14,450	+13,750	+12,980	+14,961	+15,006	+14,753	+14,753	+15,080
+ 0,390	− 0,661	− 2,307	− 3,007	− 3,777	− 1,796	− 1,751	− 2,004	− 2,004	− 1,677
+20,179	+18,654	+16,982	+16,290	+18,290	+19,645	+18,290	+17,290	+17,290	+18,401
+ 0,462	− 1,064	− 2,736	− 3,428	− 1,428	− 0,073	− 1,428	− 2,428	− 2,428	− 1,317
+23,617	+21,129	+19,617	+19,474	+22,284	+22,892	+22,617	+21,617	+21,117	+21,717
+ 1,289	− 1,199	− 2,711	− 2,854	− 0,044	+ 0,564	+ 0,289	− 0,711	− 1,211	− 0,611

Distribution, sum and mean value of the term $(t\varphi,\lambda)$ in the 36 normal Ordinates, and correction applied to each of the interpolated Ordinates in each Parallel. — The upper signs of correction apply to the positive, the lower to the negative Ordinates.

+12 **75°** −24
75,6124°
6,301° 3,151°
±1,000°C approx.

+13 **70°** −23
92,4389° 92,4371°
7,111° 4,019°
±1,1584°C

+13 **65°** −23
80,2846° 80,2844°
6,176° 3,490°
±0,7573°C

+17 **60°** −19
73,4078° 73,4084°
4,318° 3,863°
±0,2785°C

+20 **55°** −16
65,7930° 65,7918°
3,290° 4,112°
±0,2545°C

+18 **50°** −18
57,6194° 57,6206°
3,201° 3,201°
±0,6286°C

+22 **45°** −14
44,8248° 44,8254°
2,037° 3,202°
±0,4600°C

+17 **40°** −19
34,3715° 34,3725°
2,022° 1,809°
±0,5991°C

+18 **35°** −18
33,7272° 33,7262°
1,874° 1,874°
±0,5196°C

+19 **30°** −17
36,8015° 36,8005°
1,937° 2,165°
±0,7098°C

+17 **25°** −19
37,4554° 37,4492°
2,203° 1,971°
±1,3831°C

TABLE IV.

SHOWING THE CALCULATED NORMAL MEAN YEARLY TEMPERATURE AND THE ANNUAL THERMO-GEOGRAPHICAL COMPONENT OF DIFFERENT GEOGRAPHICAL POSITIONS IN THE SPECIFIED SECTIONS I—VIII OF THE NORTHERN HEMISPHERE.

φ denotes the true latitude of a geographical position or place,
$T\varphi$ the normal yearly temperature of a parallel or place of the latitude $= \varphi$,
M the calculated mean yearly temperature of the position, and
$t\varphi,\lambda$ the annual thermo-geographical component.

		SECTION VII					SECTION V					
WEST		90°	80°	70°	60°	50°	50°	40°	30°	20°	10°	0°
75°	$M=$	−16,332	−15,195	−13,842	−14,176	−10,734	−11,485	− 9,121	− 6,829	− 4,947	− 3,776	− 3,556
$T\varphi=-12{,}2947$°C	$t\varphi,\lambda=$	− 4,037	− 2,900	− 1,547	− 1,881	+ 1,561	+ 0,810	+ 3,174	+ 5,466	+ 7,348	+ 8,519	+ 8,739
70°	$M=$	−14,017	−13,359	−11,754	−11,325	− 6,157	− 6,584	− 4,441	− 2,359	− 0,607	+ 0,562	+ 0,987
$T\varphi=-\ 8{,}7209$°C	$t\varphi,\lambda=$	− 5,296	− 4,638	− 3,033	− 2,604	+ 2,564	+ 2,137	+ 4,280	+ 6,362	+ 8,114	+ 9,283	+ 9,708
65°	$M=$	−11,062	−10,883	− 9,249	− 8,499	− 2,235	− 2,330	− 0,271	+ 1,703	+ 3,343	+ 4,408	+ 4,740
$T\varphi=-\ 5{,}0129$°C	$t\varphi,\lambda=$	− 6,049	− 5,870	− 4,236	− 3,486	+ 2,778	+ 2,683	+ 4,742	+ 6,716	+ 8,356	+ 9,421	+ 9,753
60°	$M=$	− 7,462	− 7,765	− 6,339	− 5,741	+ 0,909	+ 1,127	+ 3,274	+ 5,278	+ 6,832	+ 7,682	+ 8,340
$T\varphi=-\ 1{,}2249$°C	$t\varphi,\lambda=$	− 6,237	− 6,540	− 5,114	− 4,516	+ 2,134	+ 2,352	+ 4,499	+ 6,503	+ 8,057	+ 8,907	+ 9,565
55°	$M=$	− 3,245	− 4,032	− 3,064	− 3,093	+ 3,236	+ 3,720	+ 6,140	+ 8,296	+ 9,808	+10,349	+ 9,738
$T\varphi=+\ 2{,}5838$°C	$t\varphi,\lambda=$	− 5,829	− 6,616	− 5,648	− 5,677	+ 0,652	+ 1,136	+ 3,556	+ 5,712	+ 7,224	+ 7,765	+ 7,154
50°	$M=$	+ 1,540	+ 0,262	+ 0,520	− 0,597	+ 4,762	+ 5,476	+ 8,330	+10,758	+12,258	+12,419	+11,016
$T\varphi=+\ 6{,}3507$°C	$t\varphi,\lambda=$	− 4,811	− 6,089	− 5,831	− 6,948	− 1,589	− 0,875	+ 1,979	+ 4,407	+ 5,907	+ 6,068	+ 4,665

		SECTION VIII					SECTION VI					
WEST		90°	80°	70°	60°	50°	50°	40°	30°	20°	10°	0°
50°	$M=$	+ 2,283	+ 0,790	+ 0,888	+ 2,373	+ 4,943	+ 5,669	+ 8,581	+11,104	+12,736	+13,071	+11,878
$T\varphi=+\ 6{,}3507$°C	$t\varphi,\lambda=$	− 4,068	− 5,561	− 5,463	− 3,978	− 1,408	− 0,682	+ 2,230	+ 4,753	+ 6,385	+ 6,720	+ 5,527
45°	$M=$	+ 6,972	+ 6,084	+ 6,491	+ 8,171	+10,694	+11,357	+12,586	+13,529	+13,946	+13,674	+12,610
$T\varphi=+10{,}0115$°C	$t\varphi,\lambda=$	− 3,040	− 3,928	− 3,521	− 1,841	+ 0,682	+ 1,345	+ 2,574	+ 3,517	+ 3,934	+ 3,662	+ 2,598
40°	$M=$	+11,310	+11,051	+11,706	+13,168	+15,214	+15,793	+15,713	+15,608	+15,466	+15,294	+15,086
$T\varphi=+13{,}5014$°C	$t\varphi,\lambda=$	− 2,191	− 2,450	− 1,795	− 0,333	+ 1,713	+ 2,292	+ 2,212	+ 2,107	+ 1,965	+ 1,793	+ 1,585
35°	$M=$	+15,270	+15,583	+16,288	+17,316	+18,557	+19,033	+18,039	+17,353	+17,184	+17,667	+18,906
$T\varphi=+16{,}7570$°C	$t\varphi,\lambda=$	− 1,487	− 1,174	− 0,469	+ 0,559	+ 1,800	+ 2,270	+ 1,282	+ 0,596	+ 0,427	+ 0,910	+ 2,149
30°	$M=$	+18,760	+19,614	+20,243	+20,649	+20,862	+21,231	+19,665	+18,792	+18,989	+20,539	+23,659
$T\varphi=+19{,}7177$°C	$t\varphi,\lambda=$	− 0,958	− 0,104	+ 0,525	+ 0,931	+ 1,144	+ 1,513	− 0,053	− 0,926	− 0,729	+ 0,821	+ 3,941
25°	$M=$	+21,752	+23,083	+23,553	+23,235	+22,327	+22,590	+20,726	+19,947	+20,765	+23,626	+28,888
$T\varphi=+22{,}3277$°C	$t\varphi,\lambda=$	− 0,576	+ 0,755	+ 1,225	+ 0,907	0,00	+ 0,262	− 1,602	− 2,381	− 1,563	+ 1,298	− 6,560

SECTION I						SECTION III					
0°	10°	20°	30°	40°	50°	50°	60°	70°	80°	90°	EAST
— 3,260	— 2,290	— 2,210	— 2,907	— 4,162	— 5,694	— 6,232	—10,308	—13,380	—15,246	—15,806	
+ 9,035	+10,005	+10,085	+ 9,388	+ 8,133	+ 6,601	+ 6,063	+ 1,987	— 1,085	— 2,951	— 3,511	
+ 1,666	+ 1,138	+ 0,262	— 0,866	— 2,131	— 3,401	— 4,042	— 7,086	— 9,543	—11,240	—12,055	
+10,387	+ 9,859	+ 8,983	+ 7,855	+ 6,590	+ 5,320	+ 4,679	+ 1,635	— 0,822	— 2,519	— 3,334	
+ 5,619	+ 4,120	+ 2,660	+ 1,289	+ 0,047	— 1,023	— 1,642	— 3,853	— 5,750	— 7,192	— 8,064	
+10,632	+ 9,133	+ 7,673	+ 6,302	+ 5,060	+ 2,990	+ 3,371	+ 1,160	— 0,737	— 2,179	— 3,051	
+ 8,501	+ 6,614	+ 4,948	+ 3,526	+ 2,352	+ 1,415	+ 0,950	— 0,663	— 2,041	— 3,191	— 3,887	
+ 9,726	+ 7,839	+ 6,173	+ 4,751	+ 3,577	+ 2,640	+ 2,175	+ 0,562	— 0,816	— 1,966	— 2,662	
+10,302	+ 8,616	+ 7,158	+ 5,824	+ 4,746	+ 3,882	+ 3,688	+ 2,436	+ 1,409	+ 0,686	+ 0,402	
+ 7,718	+ 6,032	+ 4,574	+ 3,240	+ 2,162	+ 1,298	+ 1,104	— 0,148	— 1,175	— 1,898	— 2,182	
+11,110	+10,148	+ 9,138	+ 8,136	+ 7,186	+ 6,335	+ 6,524	+ 5,410	+ 4,659	+ 4,375	+ 4,719	
+ 4,759	+ 3,797	+ 2,787	+ 1,785	+ 0,835	— 0,016	+ 0,173	— 0,941	— 1,692	— 1,976	— 1,632	

SECTION II						SECTION IV					
0°	10°	20°	30°	40°	50°	50°	60°	70°	80°	90°	EAST
+12,229	+10,776	+ 9,409	+ 8,148	+ 7,034	+ 6,090	+ 5,962	+ 4,822	+ 4,158	+ 4,174	+ 4,965	
+ 5,878	+ 4,425	+ 3,058	+ 1,797	+ 0,683	— 0,261	— 0,389	— 1,529	— 2,193	— 2,177	— 1,386	
+13,198	+13,023	+12,652	+12,122	+11,499	+10,874	+10,326	+10,530	+10,466	+ 9,034	+ 9,460	
+ 3,186	+ 3,011	+ 2,640	+ 2,110	+ 1,487	+ 0,862	+ 0,314	+ 0,518	+ 0,454	— 0,978	— 0,552	
+15,836	+15,898	+15,842	+15,688	+15,454	+15,190	+14,450	+15,485	+15,793	+15,202	+13,613	
+ 2,335	+ 2,397	+ 2,341	+ 2,187	+ 1,953	+ 1,689	+ 0,949	+ 1,984	+ 2,292	+ 1,701	+ 0,112	
+19,767	+19,224	+18,912	+18,811	+18,874	+19,059	+18,266	+19,652	+20,107	+19,390	+17,241	
+ 3,010	+ 2,467	+ 2,155	+ 2,054	+ 2,117	+ 2,302	+ 1,509	+ 2,895	+ 3,350	+ 2,633	+ 0,484	
+24,570	+22,774	+21,778	+21,491	+21,765	+22,412	+21,758	+23,050	+23,467	+22,715	+20,674	
+ 4,852	+ 3,056	+ 2,060	+ 1,773	+ 2,047	+ 2,694	+ 2,040	+ 3,332	+ 3,749	+ 2,997	+ 0,956	
+29,825	+26,333	+24,363	+23,725	+24,130	+25,247	+24,764	+25,732	+25,975	+25,267	+23,506	
+ 7,497	+ 4,005	+ 2,035	+ 1,397	+ 1,802	+ 2,919	+ 2,436	+ 3,404	+ 3,647	+ 2,939	+ 1,178	

TABLE V.

PROSPECT OF THERMO-GEOGRAPHICAL ELEMENTS, DERIVED FROM ACTUAL OBSERVATIONS AT 169 PLACES IN EUROPE AND ADJACENT PARTS OF ASIA AND AFRICA.

M denotes the observed mean yearly temperature,

$\Sigma\,(+Q'm)$ the statistically ascertained value of the dynamo-cosmical factor $\Sigma\,(+Qm)$, and

MV the thermo-geographical coefficient.

No.	No. in Tab. IX	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		M	$\sum (+Q'm)$	MV
							years	number of years	°C		°C
	1	2	3	4	5	6	7	8	9	10	11
1	-	Gjæsvær	71° 7′	25° 22′	7	Chall. Rep.	1870—84	15	+1,0000	3,4122	4,6759
2	-	Kistrand	70° 25′	25° 13′	10	Chall. Rep.	1870—84	15	0,7222	3,4233	5,9907
3	1	Vardø	70° 22′	31° 7′	10	Chall. Rep.	1870—84	15	0,4625	3,5665	4,7125
4	-	Alten (Bosekop)	69° 58′	23° 17′	13	Chall. Rep.	1870—84	15	0,4444	3,3791	6,6018
5	-	Tromsø	69° 39′	18° 58′	15	Chall. Rep.	1870—84	15	+2,2222	3,2468	4,7500
6	2	Kola	68° 53′	33° 1′	10	Chall. Rep.	1870—84	15	—0,5242	3,4055	7,8008
7	-	Bodø	67° 17′	14° 24′	5	Chall. Rep.	1870—84	15	+3,8889	3,3436	5,0463
8	-	Torneå	66° 24′	23° 47′	-	Dove	bef. 1848	30	—0,5250	3,5281	9,9073
			65° 51′	24° 9′	52	Chall. Rep.	1870—84	15	+0,7778	3,5331	8,8981
9	-	Haparanda	65° 50′	23° 29′	10	Chall. Rep.	1870—84	15	0,00	3,4664	8,6018
10	-	Mesen	65° 30′	44° 16′.	16	Chall. Rep.	1870—84	15	—1,8333	3,4731	8,9722
11	3	Stensele	65° 5′	17° 0′	337	Chall. Rep.	1870—84	15	+0,1075	3,5093	8,7458
12	-	Uleåborg	65° 1′	25° 8′	10	Chall. Rep.	1870—84	15	1,8333	3,4604	8,4907
13	-	Kem	64° 57′	34° 39′	13	Chall. Rep.	1870—84	15	0,6111	3,4803	8,1852
14	4	Archangel	64° 32′	40° 33′	-	Dove	bef. 1848	18	0,8483	3,5516	8,9750
			64° 33′	40° 32′	5	Chall. Rep.	1870—84	15	0,0592	3,5121	9,3842
15	-	Østersund	63° 11′	14° 38′	296	Chall. Rep.	1870—84	15	1,5556	3,5874	7,4074
16	-	Christiansund	63° 7′	7° 45′	16	Chall. Rep.	1870—84	15	6,2778	3,4773	4,2500
17	-	Kuopia	62° 54′	27° 20′	88	Chall. Rep.	1870—84	15	1,8333	3,5305	8,5648
18	-	Hernøsand	62° 38′	17° 58′	14	Chall. Rep.	1870—84	15	+3,0000	3,5230	7,1111
19	-	Røraas	62° 24′	11° 23′	629	Chall. Rep.	1870—84	15	—0,7778	3,7591	7,6574
20	-	Kaskø (Kristinestad)	62° 20′	20° 51′	8	Chall. Rep.	1870—84	15	+3,0556	3,5263	6,8241
21	-	Wiborg	60° 43′	28° 26′	-	Chall. Rep.	1870—84	15	3,3333	3,5408	7,6389
22	-	Åbo	60° 27′	21° 52′	15	Chall. Rep.	1870—84	15	4,3333	3,4468	7,5000
23	5	Bergen	60° 24′	5° 18′	-	Dove	bef. 1848	6	8,2074	3,5900	4,5281
			60° 24′	5° 20′	18	Chall. Rep.	1870—84	15	6,7317	3,5528	4,7300
24	6	St. Petersburg	59° 56′	30° 18′	-	Dove	bef. 1848	13	4,2249	3,6453	8,2020
			59° 56′	30° 18′	-	Dove	bef. 1848	10	2,5750	3,5042	8,7750
			59° 56′	30° 16′	6	Chall. Rep.	1870—84	15	3,7458	3,8333	8,8575
25	7	Christiania	59° 55′	10° 43′	23	Dove	bef. 1848	15	5,1818	3,7053	6,9005
			59° 55′	10° 43′	25	Chall. Rep.	1870—84	15	5,3017	3,6452	7,1750
			59° 55′	10° 43′	25	Mohn	-	33	5,1333	3,7369	7,0833
26	-	Upsala	59° 52′	17° 38′	24	Chall. Rep.	1870—84	15	4,6111	3,4812	6,8333
27	-	Karlstad	59° 23′	13° 30′	54	Chall. Rep.	1870—84	15	5,7778	3,6049	6,8426
28	8	Stockholm	59° 21′	18° 4′	40	Dove	bef. 1848	15	5,7063	3,4816	6,8292
			59° 21′	18° 4′	40	Dove	bef. 1848	50	5,6250	3,5115	7,0083
			59° 20′	18° 4′	44	Chall. Rep.	1870—84	15	5,3608	3,4384	6,4808
29	-	Wjatka	58° 36′	49° 41′	177	Chall. Rep.	1870—84	15	1,3333	3,5719	10,1204
30	-	Novgorod	58° 31′	31° 18′	19	Chall. Rep.	1870—84	15	4,2222	3,6587	8,5370
31	-	Dorpat	58° 23′	26° 43′	68	Chall. Rep.	1870—84	15	+4,5000	3,6151	8,0092

No.	No. in Tab. IX	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		M	$\Sigma (+Q'm)$	MV
							years	number of years	°C		°C
	1	2	3	4	5	6	7	8	9	10	11
32	63	Stornoway	58° 13′	−6° 23′	21	Chall. Rep.	1870—84	15	+7,7467	3,5155	3,0133
33	-	Mandal	58° 2′	7° 27′	16	Chall. Rep.	1870—84	15	6,7222	3,5450	5,5463
34	43	Perm	58° 1′	56° 16′	100	Chall. Rep.	1870—84	15	1,0375	3,5667	10,3808
35	-	Jönköping	57° 47′	14° 11′	98	Chall. Rep.	1870—84	15	5,8889	3,4308	6,1944
36	-	Skagen	57° 44′	10° 38′	3	Chall. Rep.	1870—84	15	7,6667	3,6488	5,6760
37	9	Göteborg	57° 41′	11° 56′	-	Dove	bef. 1848	45	7,9261	3,9504	6,1883
			57° 42′	11° 59′	7	Chall. Rep.	1870—84	15	7,1100	3,6060	6,0100
38	-	Visby	57° 39′	18° 19′	16	Chall. Rep.	1870—84	15	6,2222	3,2022	5,4260
39	-	Culloden	57° 29′	−4° 8′	31	Chall. Rep.	1870—84	15	8,0000	3,4911	3,6204
40	-	Aberdeen	57° 19′	−2° 6′	20	Chall. Rep.	1870—84	15	8,1667	3,4211	3,6111
41	-	Riga	56° 57′	24° 6′	13	Chall. Rep.	1870—84	15	6,0556	3,5614	7,5185
42	-	Vestervig	56° 47′	8° 20′	25	Chall. Rep.	1870—84	15	7,6667	3,6547	5,6852
43	-	Kalmar	56° 40′	16° 23′	10	Chall. Rep.	1870—84	15	6,7778	3,5838	6,1389
44	10	Libau	56° 31′	21° 1′	6	Chall. Rep.	1870—84	15	6,2717	3,6308	6,6250
45	-	Nishnij Novgorod	56° 20′	44° 0′	138	Chall. Rep.	1870—84	15	3,7222	3,6141	9,9722
46	-	Herning	56° 8′	8° 58′	59	Chall. Rep.	1870—84	15	6,6667	3,7261	5,4167
47	-	Edinburg	55° 58′	−3° 11′	69	Dove	bef. 1848	17	8,4250	3,6054	3,8459
			55° 58′	−3° 10′	82	Chall. Rep.	1870—84	15	8,0000	3,4570	3,7130
48	66	Glasgow	55° 53′	−4° 18′	56	Chall. Rep.	1870—84	15	8,2583	3,5341	3,6767
49	-	Samsø	55° 50′	10° 36′	20	Chall. Rep.	1870—84	15	7,5556	3,7125	5,5000
50	-	Kasan	55° 47′	49° 8′	73	Chall. Rep.	1870—84	15	3,0000	3,7204	10,4722
51	11	Moscow	55° 45′	37° 38′	125	Dove	bef. 1848	21	4,4562	3,8338	9,3647
			55° 50′	37° 33′	155	Chall. Rep.	1870—84	15	3,9067	3,6805	9,2583
52	12	Copenhagen	55° 41′	12° 35′	-	Dove	bef. 1848	45	8,0885	3,8156	6,2637
			55° 41′	12° 35′	-	Dove	bef. 1848	63	7,6553	3,8912	6,2302
			55° 41′	12° 36′	14	Chall. Rep.	1870—84	15	7,4167	3,6954	5,7300
			55° 41′	12° 36′	14	Met. Inst., Coph.	1887—91	5	7,3017	3,9275	5,7217
			55° 41′	12° 36′	14	V. Willaume-Jantzen	1861—94	34	7,4226	3,7344	5,7441
53	13	Fanø (Esbjerg)	55° 27′	8° 24′	6	Chall. Rep.	1870—84	15	7,6675	3,7195	5,4075
			55° 27′	8° 24′	6	Met. Inst., Coph.	1885—94	10	7,4317	4,0046	5,3116
54	-	Hammershus	55° 17′	14° 40′	15	Chall. Rep.	1870—84	15	7,5000	3,5088	5,5556
55	-	Königsberg	54° 43′	20° 30′	22	Chall. Rep.	1870—84	15	6,3889	3,6683	6,7600
56	-	Wilna	54° 41′	25° 18′	118	Chall. Rep.	1870—84	15	6,3889	3,6652	7,6018
57	-	Danzig	54° 20′	18° 41′	-	Dove	bef. 1848	32	7,5781	3,7386	6,2125
			54° 21′	18° 38′	22	Chall. Rep.	1870—84	15	7,1667	3,6349	6,3611
58	-	Helgoland	54° 20′	7° 51′	46	Chall. Rep.	1870—84	15	8,5556	3,8188	4,8800
59	14	Samara	54° 19′	48° 0′	60	Chall. Rep.	1870—84	15	3,5000	3,8930	10,7778
60	-	Leeds	53° 48′	−1° 33′	42	Chall. Rep.	1870—84	15	9,3333	3,4923	4,2037
61	-	Hull	53° 45′	−0° 20′	4	Chall. Rep.	1870—84	15	+9,0000	3,4199	4,1481

No.	No. in Tab. IX	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		M	$\Sigma (+Qm)$	MV
							years	number of years	°C		°C
	1	2	3	4	5	6	7	8	9	10	11
62	15	Hamburg	53° 33′	9° 58′	-	Dove	bef. 1848	18	+ 8,9073	3,9196	6,0219
			53° 33′	9° 58′	19	Chall. Rep.	1870—84	15	8,3889	3,6442	5,5000
			53° 33′	9° 59′	26	Deutsche Seew.	1876—85	10	8,2100	3,7015	5,5153
			53° 33′	9° 59′	26	Deutsche Seew.	1886—90	5	7,6808	4,2973	5,9725
63	-	Athlone	53° 25′	−8° 0′	93	Chall. Rep.	1870—84	15	9,0000	3,6161	3,7500
64	-	Dublin	53° 21′	−6° 11′	-	Dove	bef. 1848	17	9,4625	3,6204	3,9146
			53° 22′	−6° 21′	48	Chall. Rep.	1870—84	15	9,3333	3,5577	3,4260
65	16	Orel	52° 57′	36° 7′	170	Chall. Rep.	1833—68	28	4,6475	3,8361	9,3875
66	17	Berlin	52° 30′	13° 24′	31	Dove	bef. 1848	24	8,9783	3,9396	6,4492
			52° 30′	13° 23′	41	Chall. Rep.	1870—84	15	9,1667	3,6151	6,0933
67	-	Posen	52° 25′	16° 56′	82	Chall. Rep.	1870—84	15	8,5000	3,5241	6,1111
68	18	Amsterdam	52° 23′	4° 53′	-	Dove	bef. 1848	12	9,9200	3,9675	5,6933
			52° 22′	4° 53′	9	Chall. Rep.	1870—84	15	9,4583	3,6360	4,9400
69	19	Warsaw	52° 13′	21° 2′	120	Chall. Rep.	1870—84	15	7,3950	3,6394	7,2092
70	69	Valentia	51° 55′	−10° 18′	7	Chall. Rep.	1870—84	15	10,6942	3,8165	2,6308
71	70	Oxford	51° 46′	−1° 16′	-	Dove	bef. 1848	2	9,4400	3,9505	4,2600
			51° 46′	−1° 16′	65	Chall. Rep.	1870—84	15	9,7775	3,4985	4,1475
72	47	Orenburg	51° 46′	55° 6′	69	Dove	bef. 1848	8	1,6983	3,8931	11,5767
			51° 46′	55° 6′	91	Chall. Rep.	1870—84	15	3,7375	4,0032	11,8912
73	-	Kursk	51° 45′	36° 0′	210	Chall. Rep.	1833—68	28	5,1111	3,9176	9,2500
74	71	Pembroke	51° 41′	−5° 30′	46	Chall. Rep.	1870—84	15	10,1375	3,6793	3,1842
75	-	Saratow	51° 38′	45° 27′	187	Chall. Rep.	1870—84	15	5,6222	3,9522	10,7222
76	-	Göttingen	51° 32′	9° 56′	150	Chall. Rep.	1870—84	15	8,3333	3,5588	5,6018
77	-	Tschernigow	51° 29′	31° 20′	130	Chall. Rep.	1870—84	15	7,0000	3,7782	8,6760
78	20	London-Greenwich	51° 30′	0° 0′	48	Dove	bef. 1848	10	10,3458	3,9016	4,6520
			51° 30′	0° 0′	48	Dove	bef. 1848	49	10,4646	3,8077	4,6708
			51° 30′	0° 0′	48	Dove	bef. 1848	3	9,4154	4,4977	4,4580
			51° 30′	0° 0′	48	Chall. Rep.	1870—84	15	10,1533	3,6789	4,5417
79	-	Leipzig	51° 20′	12° 23′	118	Chall. Rep.	1870—84	15	8,1667	3,5792	6,0648
80	-	Düsseldorff	51° 14′	6° 47′	28	Dove	bef. 1848	13	10,9375	4,0229	5,4896
81	-	Breslau	51° 7′	17° 2′	116	Dove	bef. 1848	9	8,3021	4,0878	6,9479
			51° 7′	17° 2′	147	Chall. Rep.	1870—84	15	8,1667	3,7016	6,5463
82	-	Dresden	51° 3′	13° 44′	113	Dove	bef. 1848	11	9,498	3,8367	6,5316
83	-	Cologne	50° 56′	6° 57′	60	Chall. Rep.	1870—84	15	10,1111	3,5962	5,1944
84	-	Brussels	50° 51′	4° 22′	-	Dove	bef. 1848	10	10,2677	4,1250	5,3073
			50° 51′	4° 22′	57	Chall. Rep.	1870—84	15	10,2778	3,5000	4,9260
85	72	Isle of Wight	50° 45′	−1° 20′	-	Dove	bef. 1848	10	10,2300	3,5290	4,7700
		(Osborne)	50° 45′	−1° 16′	53	Chall. Rep.	1870—84	15	10,3333	3,8288	4,5733
86	-	Kiew	50° 27′	30° 30′	183	Chall. Rep.	1870—84	15	+ 6,9444	3,8412	8,5370

No.	No. in Tab. IX	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		M	$\Sigma (+Qm)$	MV
							years	number of years	°C		°C
	1	2	3	4	5	6	7	8	9	10	11
87	21	Francfort	50° 10′	8° 37′	104	Dove	bef. 1848	20	+ 9,7992	3,9102	5,9507
			50° 10′	8° 37′	104	Dove	bef. 1848	30	9,7275	3,9014	6,1142
			50° 10′	8° 37′	104	Physik. Verein	1837—56	20	9,5535	3,9742	6,2783
88	-	Falmouth	50° 9′	—5° 4′	64	Chall. Rep.	1870—84	15	10,6667	3,6923	3,1111
89	-	Prague	50° 5′	16° 46′	183	Dove	bef. 1848	14	10,1229	4,0098	7,2025
			50° 5′	14° 25′	201	Chall. Rep.	1870—84	15	8,8889	3,6544	6,4630
90	-	Cracow	50° 4′	19° 57′	220	Chall. Rep.	1870—84	15	7,6111	3,7424	6,8611
91	-	Charkow	50° 4′	36° 9′	126	Chall. Rep.	1870—84	15	7,0556	3,7187	8,8148
92	-	Lemberg	49° 50′	24° 1′	298	Chall. Rep.	1870—84	15	7,0000	3,7308	7,1858
93	-	Pultava	49° 33′	34° 38′	140	Chall. Rep.	1870—84	15	6,7778	3,8231	9,2031
94	-	Carlsruhe	49° 1′	8° 25′	100	Dove	bef. 1848	52	10,3719	3,8855	6,0974
			49° 0′	8° 25′	123	Chall. Rep.	1870—84	15	9,6111	3,5197	5,7685
95	22	Paris	48° 50′	2° 20′	36	Dove	bef. 1848	39	10,7281	3,9287	5,2200
			48° 48′	2° 21′	78	Chall. Rep.	1870—84	15	10,4683	3,4956	4,9067
			48° 48′	2° 21′	78	M. E. Renou	1761-1880	120	10,6350	3,8804	5,2483
96	-	Stuttgart	48° 47′	9° 11′	270	Chall. Rep.	1870—84	15	9,5556	3,6441	5,9722
97	-	Tübingen	48° 31′	9° 3′	310	Dove	bef. 1848	10	8,2396	3,9667	6,3205
98	73	Brest	48° 23′	—4° 30′	63	Chall. Rep.	1870—84	15	11,7125	3,6690	3,7408
99	23	Vienna	48° 13′	16° 23′	141	Dove	bef. 1848	60	10,5688	3,9617	7,2342
			48° 14′	16° 22′	202	Chall. Rep.	1870—84	15	9,3342	3,6497	6,6583
100	-	Munich	48° 9′	11° 36′	493	Dove	bef. 1848	25	9,0990	4,0126	7,0781
			48° 9′	11° 34′	529	Chall. Rep.	1870—84	15	7,2222	3,6776	6,2315
101	-	Salzburg	47° 48′	13° 3′	436	Chall. Rep.	1870—84	15	8,1898	3,7711	6,4452
102	-	Basel	47° 34′	7° 32′	235	Dove	bef. 1848	17	9,5416	3,9095	6,0688
			47° 33′	7° 35′	278	Chall. Rep.	1870—84	15	9,6111	3,6092	5,8148
103	24	Buda-Pest	47° 29′	19° 3′	254	Dove	bef. 1848	9	8,5983	4,1493	7,3387
			47° 29′	19° 3′	254	Dove	bef. 1848	17	10,3167	4,1641	7,9000
			47° 30′	19° 2′	153	Chall. Rep.	1870—84	15	9,7875	3,6972	7,2296
104	-	Nantes	47° 13′	—1° 33′	41	Chall. Rep.	1870—84	15	11,5000	3,5725	4,3333
105	-	Taganrog	47° 12′	38° 59′	35	Chall. Rep.	1870—84	15	8,8889	4,0400	9,3518
106	-	Kischeneff	46° 59′	28° 51′	87	Chall. Rep.	1870—84	15	9,5556	3,7039	7,9907
107	-	Bern	46° 57′	7° 26′	573	Chall. Rep.	1870—84	15	8,2222	3,5556	5,9260
108	-	Chur	46° 50′	9° 38′	590	Dove	bef. 1845	5	9,5021	3,9929	6,1541
109	-	Klagenfurt	46° 37′	14° 18′	438	Chall. Rep.	1870—84	15	7,4352	3,8908	7,7516
110	-	Obirgipfel	46° 30′	14° 17′	2044	Chall. Rep.	1879—86	8	0,3379	3,3910	4,9583
111	-	Odessa	46° 29′	30° 44′	65	Chall. Rep.	1870—94	15	10,0000	3,7854	8,1667
112	25	Astrakhan	46° 21′	48° 8′	22	Dove	bef. 1848	-	10,0267	4,3888	10,9305
			46° 21′	48° 2′	—21	Chall. Rep.	1870—84	15	+ 9,8942	3,8085	9,9758
113	-	Great St. Bernard	45° 50′	6° 6′	2404	Dove	bef. 1848	-	— 1,0271	3,8389	5,0084
			45° 52′	7° 11′	2480	Chall. Rep.	1870—84	15	— 1,2778	3,5641	5,1481

No.	No. in Tab. IX	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		M	$\Sigma (+Q'm)$	MV
							years	number of years	°C		°C
	1	2	3	4	5	6	7	8	9	10	11
114	-	Clermont	45° 47′	3° 5′	395	Chall. Rep.	1870—84	15	+10,8333	3,5496	4,9630
115	-	Hermanstadt	45° 47′	24° 9′	421	Chall. Rep.	1870—84	15	8,3889	4,0597	7,5556
116	-	Lyon	45° 46′	4° 49′	194	Chall. Rep.	1870—84	15	11,6111	3,5866	5,9444
117	-	Triest	45° 39′	13° 46′	26	Chall. Rep.	1870—84	15	13,9444	3,4791	6,1852
118	-	Venice	45° 32′	12° 20′	21	Chall. Rep.	1870—84	15	13,3889	3,5294	6,6667
119	-	Milano	45° 28′	9° 11′	226	Dove	bef. 1848	55	12,8803	3,8542	6,9823
			45° 28′	9° 11′	147	Chall. Rep.	1870—84	15	13,0000	3,5046	7,0092
120	-	Kertsch	45° 21′	36° 29′	6	Chall. Rep.	1870—84	15	11,5556	3,8063	7,8240
121	-	Stawropol	45° 3′	41° 59′	585	Chall. Rep.	1870—84	15	8,6111	3,7652	7,4260
122	-	Simferopol	44° 56′	34° 5′	260	Chall. Rep.	1821—72	37	10,1111	3,8377	6,7870
123	-	Pola	44° 52′	13° 50′	32	Chall. Rep.	1870—84	15	13,8333	3,4862	5,8426
124	-	Bordeaux	44° 50′	—0° 35′	-	Dove	bef. 1848	10	13,906	3,5331	5,2812
125	26	Sebastopol	44° 36′	33° 32′	-	Dove	bef. 1848	10	11,604	3,8701	6,7500
			44° 37′	33° 31′	61	Chall. Rep.	1870—84	15	12,4544	3,6612	6,6473
126	27	Bukharest	44° 27′	26° 8′	-	Dove	bef. 1848	2	7,9692	3,7484	7,5725
			44° 25′	26° 5′	93	Chall. Rep.	1870—84	15	10,5425	3,8625	8,0904
127	-	Genoa	44° 24′	8° 55′	54	Chall. Rep.	1870—84	15	15,5556	3,6818	5,2500
128	-	Florence	43° 46′	11° 15′	73	Chall. Rep.	1870—84	15	14,3889	3,5626	6,0185
129	-	Ancona	43° 37′	13° 31′	30	Chall. Rep.	1870—84	15	15,6667	3,4718	6,2685
130	28	Montpellier	43° 36′	3° 53′	31	Dove	bef. 1848	11	15,2800	3,5759	6,2400
			43° 37′	3° 53′	37	Chall. Rep.	1870—84	15	14,4025	3,5075	5,3192
131	-	Santander	43° 29′	—3° 50′	40	Chall. Rep.	1870—84	15	14,0000	4,0952	3,1852
132	-	Marseille	43° 17′	5° 22′	75	Chall. Rep.	1870—84	15	14,1667	3,6277	4,7805
133	-	Ragusa	42° 38′	18° 7′	15	Chall. Rep.	1870—84	15	16,2222	3,5681	5,2870
134	-	Sophia	42° 32′	23° 23′	538	Chall. Rep.	1870—84	15	10,4444	3,8514	7,9167
135	-	Ajaccio	41° 55′	8° 44′	18	Chall. Rep.	1870—84	15	16,6667	3,7594	4,7037
136	29	Rome	41° 54′	12° 25′	50	Dove	bef. 1848	20	15,8272	3,8715	5,5478
			41° 54′	12° 29′	50	Chall. Rep.	1870—84	15	15,4858	3,5900	5,5608
137	-	Tiflis	41° 41′	45° 17′	-	Dove	bef. 1848	1	12,6354	3,6802	8,0209
			41° 43′	44° 47′	409	Chall. Rep.	1870—84	15	13,1667	3,8538	7,5648
138	-	Batum	41° 40′	41° 38′	3	Chall. Rep.	1870—84	15	15,1111	3,9051	5,7130
139	-	Trebisonde	41° 1′	39° 45′	28	Chall. Rep.	1870—84	15	14,6111	3,6727	5,6111
140	30	Constantinople	41° 0′	28° 59′	-	Chall. Rep.	1870—84	15	14,2308	3,8861	5,8608
141	-	Naples	40° 52′	14° 15′	-	Dove	bef. 1848	13	15,3115	3,6380	5,1469
			40° 52′	14° 15′	149	Chall. Rep.	1870—84	15	16,1667	3,6753	5,2407
142	-	Alexandropol	40° 48′	43° 49′	1470	Chall. Rep.	1870—84	15	5,4444	4,1367	8,9630
143	78	Madrid	40° 24′	—3° 42′	655	Chall. Rep.	1870—84	15	13,6158	3,2628	6,3102
144	-	Baku	40° 22′	49° 50′	2	Chall. Rep.	1870—84	15	15,1667	3,9220	7,4444
145	-	Eriwan	40° 10′	44° 30′	985	Chall. Rep.	1870—84	15	11,1111	4,1945	9,9815
146	-	Corfu	39° 38′	19° 33′	30	Chall. Rep.	1870—84	15	+18,0556	3,7032	5,3148

No.	No. in Tab. IX	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		M	$\Sigma (+Q'm)$	MV
							years	number of years	°C		°C
	1	2	3	4	5	6	7	8	9	10	11
147	-	Palma	39° 33′	2° 37′	20	Chall. Rep.	1870—84	15	+17,7778	3,7310	5,0092
148	-	Cagliari	39° 30′	9° 0′	55	Chall. Rep.	1870—84	15	17,2778	3,6454	4,7592
149	-	Valencia	39° 28′	—0° 23′	18	Chall. Rep.	1870—84	15	17,1667	3,7761	4,6852
150	79	Lisbon	38° 42′	—9° 9′	-	Dove	bef. 1848	5	16,3333	3,7372	3,7167
			38° 42′	—9° 8′	102	Chall. Rep.	1870—84	15	15,4867	3,6600	3,4300
151	-	Smyrna	38° 26′	27° 10′	8	Chall. Rep.	1864—70	7	17,3889	3,8253	5,8796
152	-	Messina	38° 12′	15° 39′	54	Chall. Rep.	1870—84	15	18,7222	3,6599	4,9815
153	-	Palermo	38° 7′	13° 21′	72	Chall. Rep.	1870—84	15	17,5556	3,7812	4,4815
154	31	Athens	37° 58′	23° 44′	103	Chall. Rep.	1859—82	24	17,2775	3,7535	6,0825
155	-	Syracusa	37° 3′	15° 15′	22	Chall. Rep.	1870—84	15	18,2222	3,5782	4,8704
156	32	Algiers	36° 47′	3° 3′	-	Dove	bef. 1848	3 1/2	17,9228	4,1585	4,2292
			36° 47′	3° 4′	22	Chall. Rep.	1870—84	15	17,9492	3,6883	4,1992
157	83	Gibraltar	36° 7′	—5° 21′	-	Dove	bef. 1848	2	19,6907	3,3007	3,6700
			36° 8′	—5° 20′	16	Chall. Rep.	1870—84	15	18,5142	3,6611	3,6892
158	33	Malta	35° 53′	14° 30′	21	Chall. Rep.	1870—84	15	19,2267	3,8026	4,2928
159	-	Tangier	35° 45′	—5° 47′	61	Chall. Rep.	1879—85	6	17,8333	3,5981	3,5648
160	-	Crete (la Canée)	35° 30′	24° 0′	34	Chall. Rep.	1879—85	6 1/2	18,1111	3,6458	4,8611
161	-	Beyrout	35° 28′	35° 54′	34	Chall. Rep.	1876—86	11	20,1667	4,4112	4,3704
162	34	Bagdad	33° 21′	44° 22′	-	Dove	bef. 1848	1	23,1875	4,5843	8,2612
			33° 21′	44° 26′	12	Chall. Rep.	1861—62	1	23,3375	4,1000	7,8942
163	35	Tripolis	32° 53′	13° 11′	30	Chall. Rep.	1819—21	4	20,6300	4,4314	4,0917
164	36	Jerusalem	31° 47′	35° 13′	732	Chall. Rep.	1863—81	19	17,2175	4,9546	5,0975
165	-	Port Said	31° 16′	32° 18′	6	Chall. Rep.	1880—85	5 1/2	18,9444	4,0917	4,1297
166	37	Alexandria	31° 12′	29° 53′	19	Chall. Rep.	1870—84	15	20,5375	4,6294	3,6592
167	-	Cairo	30° 2′	31° 15′	-	Dove	bef. 1848	1	22,3166	4,2309	5,3473
			30° 5′	31° 17′	33	Chall. Rep.	1868—81	14	21,7778	4,1808	5,3518
168	-	Suez	29° 59′	32° 31′	7	Chall. Rep.	1880—85	5 1/2	19,8333	4,2403	5,0648
169	38	Kouka	13° 10′	14° 30′	275	Dove	bef. 1848	2	+28,746	-	-

TABLE VI.

PROSPECT OF THERMO-GEOGRAPHICAL ELEMENTS, DERIVED FROM ACTUAL OBSERVATIONS AT 72 PLACES IN ASIA.

M denotes the observed mean yearly temperature,

$\Sigma\,(+Q'm)$ the statistically ascertained value of the dynamo-cosmical factor $\Sigma\,(+Qm)$, and

MV the thermo-geographical coefficient.

No.	No. in Tab. IX	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		M	$\Sigma (+Q'm)$	MV
							years	number of years	°C		°C
	1	2	3	4	5	6	7	8	9	10	11
1	-	Ustjansk	70° 58′	138° 24′	-	Dove	bef. 1848	2	—15,5500	3,2914	16,6354
2	-	Wercbojansk	67° 34′	133° 51′	140	Chall. Rep.	1869—87	9	—18,2732	3,9239	21,6150
3	39	Obdorsk	66° 31′	66° 35′	24	Chall. Rep.	1870—84	15	— 7,4542	3,2902	11,3975
4	40	Turuchansk	65° 55′	87° 38′	19	Chall. Rep.	1877—87	10½	— 7,6667	3,2064	12,5290
5	-	Beresow	63° 56′	65° 4′	36	Chall. Rep.	1870—84	15	— 4,5000	3,4538	11,4167
6	-	Jakutsk	62° 1′	129° 44′	-	Dove	bef. 1848	2	—10,6125	4,0913	18,7438
			62° 2′	129° 45′	102	Chall. Rep.	1829—73	35	—11,1667	3,9517	19,7222
7	41	Ust-Syssolsk	61° 40′	50° 51′	100	Chall. Rep.	1817—67	51	+ 0,2825	3,5188	9,4758
8	-	Olekminsk	60° 22′	120° 26′	122	Chall. Rep.	1870—84	15	— 7,2778	3,8554	17,0278
9	-	Narym	59° 21′	80° 16′	60	Chall. Rep.	1870—84	15	— 1,5556	3,5222	12,4907
10	-	Ochotsk	59° 20′	142° 40′	4	Chall. Rep.	1870—84	15	— 5,7278	4,0242	12,2963
11	-	Enisseisk	58° 27′	92° 6′	84	Chall. Rep.	1870—84	15	— 1,6667	3,5462	12,8056
12	42	Tobolsk	58° 12′	68° 16′	108	Chall. Rep.	1870—84	15	+ 0,7092	3,6539	11,6808
13	-	Banschtschikowa	58° 3′	108° 35′	300	Chall. Rep.	1870—84	15	— 4,7778	3,7407	14,9630
14	-	Catharinenburg	56° 50′	60° 34′	241	Dove	bef. 1848	7	+ 0,5000	3,6170	10,6250
			56° 49′	60° 38′	272	Chall. Rep.	1870—84	15	+ 0,8333	3,7261	10,4537
15	44	Tomsk	56° 30′	85° 10′	91	Dove	bef. 1848	9	— 0,4267	3,5643	10,9467
			56° 30′	85° 10′	91	Dove	bef. 1848	5	— 1,3692	3,7075	12,2772
			56° 30′	84° 58′	77	Chall. Rep.	1870—84	15	— 0,5842	3,5951	12,1658
16	-	Krassnojarsk	56° 1′	92° 49′	152	Chall. Rep.	1870—84	15	+ 0,2778	3,6925	12,3426
17	-	Staro Ssidorowa	55° 26′	65° 10′	98	Chall. Rep.	1870—84	15	+ 1,0000	4,1111	13,0185
18	-	Berings Island	55° 12′	165° 55′	6	Chall. Rep.	1882—86	4	+ 2,1111	4,1667	4,1667
19	45	Omsk	54° 58′	73° 20′	79	Chall. Rep.	1870—84	15	+ 0,1658	3,6772	12,4258
20	-	Wercholensk	54° 8′	105° 30′	472	Chall. Rep.	1870—84	15	— 4,4444	3,9456	14,7592
21	46	Barnaul	53° 20′	83° 27′	122	Dove	bef. 1848	6	— 0,4267	3,8910	12,4362
			53° 20′	83° 47′	140	Chall. Rep.	1870—84	15	+ 0,8975	3,7821	12,2492
22	-	Nicolajewsk	53° 8′	140° 45′	18	Chall. Rep.	1870—84	15	— 2,1111	3,9407	12,9167
23	-	Petropaulowsk	53° 0′	158° 39′	15	Chall. Rep.	1828—53	7	+ 2,0000	3,4000	7,2407
24	-	Irkutsk	52° 17′	104° 17′	425	Dove	bef. 1848	10	+ 0,3416	3,8298	11,4306
			52° 16′	104° 16′	468	Chall. Rep.	1870—84	15	— 0,9444	3,8539	12,7037
25	-	Ulala	51° 39′	86° 2′	400	Chall. Rep.	1870—84	15	+ 1,3333	3,7616	11,9815
26	-	Nertschinsk	51° 18′	119° 20′	658	Dove	bef. 1848	5	— 3,9625	4,1542	15,2062
			51° 19′	119° 37′	660	Chall. Rep.	1870—84	15	— 3,1667	4,0124	15,0092
27	48	Akmolinsk	51° 12′	71° 23′	306	Chall. Rep.	1870—84	15	+ 1,4808	3,8574	12,5491
28	-	Selenjinsk	51° 6′	106° 53′	570	Chall. Rep.	1870—84	15	— 0,5556	3,9509	14,8889

No.	No. in Tab. IX	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		M °C	$\Sigma (+Qm)$	MV °C
							years	number of years			
	1	2	3	4	5	6	7	8	9	10	11
29	-	Due	50° 50′	142° 7′	100	Chall. Rep.	1870—84	15	+ 0,7778	4,1053	10,1111
30	49	Semipolatinsk	50° 24′	80° 13′	181	Chall. Rep.	1870—84	15	+ 2,8058	3,8356	13,0499
31	-	Kjachta	50° 20′	106° 35′	718	Chall. Rep.	1870—84	15	— 1,2778	3,9543	13,6204
32	-	Blagowetschensk	50° 15′	127° 38′	110	Chall. Rep.	1870—84	15	+ 0,0556	3,8501	14,5092
33	50	Irgis	48° 37′	61° 16′	112	Chall. Rep.	1870—84	15	+ 5,2417	4,0400	13,2297
34	-	Chaborowka	48° 26′	135° 7′	18	Chall. Rep.	1870—84	15	+ 0,2778	4,0207	14,4074
35	-	Urga	47° 55′	106° 50′	1311	Chall. Rep.	1870—84	15	— 1,1117	3,9690	13,0463
36	-	Gurjew	47° 7′	51° 55′	—18	Chall. Rep.	1870—84	15	+ 8,6111	3,9832	10,9907
37	-	Kasalinsk	45° 46′	62° 7′	45	Chall. Rep.	1870—84	15	8,0000	4,0667	11,8611
38	-	Port Alexandrovsky	44° 31′	50° 15′	—25	Chall. Rep.	1870—84	15	11,4444	3,7603	9,2963
39	-	Olga	43° 44′	135° 20′	45	Chall. Rep.	1875—85	10	4,2222	4,0038	9,7130
40	-	Wjernoje	43° 16′	76° 53′	744	Chall. Rep.	1870—84	15	8,1111	4,1758	11,2130
41	-	Wladiwostock	43° 7′	131° 54′	17	Chall. Rep.	1875—85	10	4,5556	4,2594	10,4908
42	-	Sapporo	43° 4′	141° 23′	18	Chall. Rep.	1881—86	6	6,5556	3,9658	8,5926
43	-	Askold	42° 44′	132° 21′	25	Chall. Rep.	1875—85	10	4,5556	4,2209	10,0833
44	-	Hakodate	41° 46′	140° 44′	3	Chall. Rep.	1881—86	6	8,0556	4,1406	7,3611
			41° 46′	140° 44′	3	Chall. Rep.	1859—86	14	8,6667	4,1361	7,3148
45	51	Petro-Alexandrowsk	41° 28′	61° 5′	100	Chall. Rep.	1870—84	15	12,6283	4,0651	10,6363
46	52	Taschkent	41° 19′	69° 16′	462	Chall. Rep.	1870—84	15	13,5425	3,6328	8,4875
47	-	Margelan	40° 28′	71° 43′	610	Chall. Rep.	1870—84	15	13,8333	3,8476	9,5833
48	-	Krasnowodsk	40° 0′	52° 39′	—21	Chall. Rep.	1870—84	15	15,9444	3,9024	8,1667
49	-	Pekin	39° 54′	116° 26′	-	Dove	bef. 1848	$5\frac{1}{2}$	12,6525	4,2215	10,4834
			39° 54′	116° 26′	-	Dove	bef. 1848	4	11,8250	4,3089	9,1834
			39° 57′	116° 28′	37	Chall. Rep.	1870—84	15	11,8333	4,1625	10,0278
50	53	Samarkand	39° 39′	66° 57′	725	Chall. Rep.	1870—84	15	14,1117	3,5802	8,1200
51	-	Miyako	39° 38′	141° 59′	30	Chall. Rep.	1881—86	6	9,5556	4,1374	6,9722
52	-	Tientsin	39° 9′	117° 16′	9	Chall. Rep.	1870—84	15	12,8889	4,0077	9,6481
53	-	Taku	38° 59′	117° 40′	5	Chall. Rep.	1870—84	15	11,8889	4,4083	9,7963
54	-	Niigata	37° 55′	139° 3′	10	Chall. Rep.	1881—86	6	12,0556	3,9314	7,4260
55	-	Merv	37° 36′	61° 47′	285	Chall. Rep.	1885—86	1	15,3333	3,6514	9,6018
56	-	Ashur-Ade	36° 54′	53° 35′	—24	Chall. Rep.	1870—84	15	17,2222	4,3797	7,5833
57	-	Tokio	35° 41′	139° 45′	21	Chall. Rep.	1881—86	6	13,2778	4,0691	7,0833
			35° 41′	139° 45′	21	Chall. Rep.	1872—86	14	13,5000	3,8636	7,0833
58	-	Kioto	35° 1′	135° 46′	50	Chall. Rep.	1881—86	6	13,5000	3,9904	7,7222
59	-	Peschawar	34° 2′	71° 37′	338	Chall. Rep.	1870—84	15	+21,3333	4,2732	7,2407

No.	No. in Tab. IX	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		M	ν $(+Q'm)$	MV
							years	number of years	°C		°C
	1	2	3	4	5	6	7	8	9	10	11
60	-	Shimonoseki	33° 58′	130° 57′	41	Chall. Rep.	1881—86	6	+14,6111	4,0508	6,6389
61	-	Nagasaki	32° 44′	129° 52′	58	Chall. Rep.	1881—86	6	15,4444	4,0223	6,6667
			32° 44′	129° 52′	58	Chall. Rep.	1871—86	13	16,1667	3,7577	6,7500
62	-	Lahore	31° 44′	74° 20′	223	Chall. Rep.	1870—84	15	24,1667	5,3406	6,8240
63	-	Shanghai	31° 14′	121° 28′	-	Chall. Rep.	1847—64	18	15,3889	3,7257	7,7963
64	-	Zeikiwej	31° 12′	121° 26′	7	Chall. Rep.	1873—84	12	15,2222	3,8065	7,6481
65	-	Hankow	30° 32′	114° 19′	80	Chall. Rep.	1877—81	5	16,7778	3,9725	8,0185
66	-	Quetta	30° 11′	67° 3′	1677	Chall. Rep.	1868—85	8	14,3333	3,7165	6,6759
67	54	Mooltan	30° 10′	71° 33′	128	Chall. Rep.	1870—84	15	24,4733	4,8034	6,8745
68	-	Bushire	28° 59′	50° 49′	8	Chall. Rep.	1878—86	9	23,1111	-	-
69	55	Delhi	28° 40′	77° 16′	219	Chall. Rep.	1870—84	15	25,1017	-	-
70	56	Benares	25° 18′	82° 56′	94	Dove	bef. 1848	$2\,^3/_4$	26,8150	-	-
			25° 20′	83° 2′	81	Chall. Rep.	1870—84	15	25,4542	-	-
71	57	Calcutta	22° 38′	88° 20′	24	Dove	bef. 1848	4	28,0017	-	-
			22° 32′	88° 20′	7	Chall. Rep.	1870—84	15	25,7492	-	-
72	58	Bombay	18° 56′	72° 54′	-	Dove	bef. 1848	$1\,^1/_3$	27,3633	-	-
			18° 54′	72° 49′	11	Chall. Rep.	1870—84	15	+26,3133	-	-

TABLE VII.

PROSPECT OF THERMO-GEOGRAPHICAL ELEMENTS, DERIVED FROM ACTUAL OBSERVATIONS AT 87 PLACES IN THE NORTH-ATLANTIC, INCLUDING GREENLAND, ICELAND, THE FÆRÖE ISLES AND OTHER ISLANDS.

M denotes the observed mean yearly temperature,

$\Sigma\,(+Q'm)$ the statistically ascertained value of the dynamo-cosmical factor $\Sigma\,(+Qm)$, and

MV the thermo-geographical coefficient.

No.	No. in Tab. IX	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		M	$\Sigma(+Qm)$	MV
							years	number of years	°C		°C
	1	2	3	4	5	6	7	8	9	10	11
1	90	Upernivik	72° 47′	55° 53′	12	Chall. Rep.	1874—84	11	— 8,0883	4,0662	8,6800
			72° 48′	55° 54′	12	Met. Inst., Coph.	1875—83	9	— 8,2000	4,0462	8,7667
2	59	Jan Mayen	70° 59′	8° 28′	10	Chall. Rep.	1882—83	1	— 2,3058	4,2103	4,0741
3	91	Jacobshavn	69° 13′	50° 55′	13	Chall. Rep.	1874—84	11	— 4,9083	3,6806	7,6116
			69° 13′	51° 2′	13	Met. Inst., Coph.	1866—83	18	— 5,1833	3,6477	7,6500
4	-	Egedesminde	68° 43′	52° 44′	4	Chall. Rep.	1874—84	11	— 4,7400	3,7613	7,2217
5	-	Grimsey	66° 34′	18° 3′	2	Chall. Rep.	1870—84	15	+ 1,6117	3,7020	3,5283
6	-	Akureyri	65° 39′	18° 10′	2	Chall. Rep.	1870—84	15	+ 2,4500	3,4758	4,3100
7	-	Sukkertoppen	65° 24′	55° 14′	-	Chall. Rep.	1874—84	11	— 0,8467	3,6143	6,2689
8	60	Stykkisholm	65° 5′	22° 46′	11	Chall. Rep.	1870—74	15	+ 2,8525	3,5677	4,0542
			65° 5′	22° 46′	11	Met. Inst., Coph.	1846—83	38	+ 2,8417	3,5586	4,0083
9	-	Berufjord	64° 40′	14° 15′	18	Chall. Rep.	1870—84	15	+ 2,7592	3,6973	3,5375
10	92	Godthaab	64° 10′	52° 24′	-	Dove	bef. 1848	13 1/2	— 2,9033	3,8731	5,4320
			64° 11′	51° 45′	11	Chall. Rep.	1874—84	11	— 1,8150	3,6195	5,1850
			64° 10′	51° 44′	11	Met. Inst., Coph.	1866—83	18	— 1,8833	3,6233	5,1833
11	-	Reykjavik	64° 8′	21° 55′	-	Dove	bef. 1848	15	+ 4,1238	3,2661	5,0700
			64° 9′	22° 0′	7	Chall. Rep.	1870—84	15	4,2458	3,4266	4,3942
12	-	Vestmanø	63° 26′	20° 18′	8	Chall. Rep.	1870—84	15	5,4450	3,2987	3,1475
13	61	Thorshavn	62° 2′	6° 46′	-	Dove	bef. 1848	3	7,5608	3,2402	3,0777
			62° 2′	6° 43′	4	Chall. Rep.	1870—84	15	6,4392	3,5248	2,6441
14	62	Ivigtut	61° 12′	48° 11′	5	Chall. Rep.	1874—84	11	0,8375	3,6609	5,4196
			61° 12′	48° 11′	5	Met. Inst., Coph.	1875—83	9	1,0083	3,6374	5,2084
15	-	North Unst	60° 51′	0° 53′	70	Chall. Rep.	1870—84	15	7,2222	3,7534	2,5370
16	-	Julianehaab	60° 44′	45° 59′	8	Chall. Rep.	1874—84	11	0,9167	4,2892	5,1850
17	80	St. Michael	37° 45′	25° 15′	-	Dove	bef. 1848	1	16,8978	4,3758	2,2625
18	84	Funchal	32° 48′	16° 56′	25	Dove	bef. 1848	1	19,7833	4,4534	2,0167
19	107	Bermuda	32° 20′	64° 50′	-	Dove	bef. 1848	1	19,6667	3,8130	3,7160
			32° 17′	64° 14′	37	Chall. Rep.	1870—84	15	21,3158	3,8940	3,4035
20	89	Las Palmas	27° 28′	17° 48′	9	Chall. Rep.	1880—84	5	20,8608	-	-
21	64	North Atlantic	57° 30′	47° 30′	-	Chall. Rep.	-	5 2/3	1,9625	3,8384	4,5725
22	-	—	-	42° 30′	-	Chall. Rep.	-	5 2/3	3,4444	3,9626	3,9260
23	-	—	-	37° 30′	-	Chall. Rep.	-	5 2/3	4,6667	3,8947	3,4259
24	-	—	-	32° 30′	-	Chall. Rep.	-	5 2/3	5,7725	3,9546	3,1158
25	-	—	-	27° 30′	-	Chall. Rep.	-	5 2/3	6,8333	3,8625	2,8611
26	-	—	-	22° 30′	-	Chall. Rep.	-	5 2/3	7,6667	3,9459	2,7037
27	-	—	-	17° 30′	-	Chall. Rep.	-	5 2/3	8,4444	3,7532	2,6760
28	65	—	-	12° 30′	-	Chall. Rep.	-	5 2/3	9,0325	3,6608	2,6892
29	67	North Atlantic	52° 30′	47° 30′	-	Chall. Rep.	-	5 2/3	4,3283	4,1849	4,4583
30	-	—	-	42° 30′	-	Chall. Rep.	-	5 2/3	6,7222	4,1443	3,7222
31	-	—	-	37° 30′	-	Chall. Rep.	-	5 2/3	+ 8,4444	3,8941	3,0648

No.	No. in Tab. IX	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		M	$\Sigma (+Q'm)$	MV
							years	number of years	°C		°C
	1	2	3	4	5	6	7	8	9	10	11
32	-	North Atlantic	52° 30′	32° 30′	-	Chall. Rep.	-	$5^2/_3$	+ 9,5642	3,8835	2,6575
33	-	—	-	27° 30′	-	Chall. Rep.	-	$5^2/_3$	10,3889	3,7941	2,3889
34	-	—	-	22° 30′	-	Chall. Rep.	-	$5^2/_3$	11,0556	3,6029	2,2685
35	-	—	-	17° 30′	-	Chall. Rep.	-	$5^2/_3$	11,5000	3,6770	2,2130
36	68	—	-	12° 30′	-	Chall. Rep.	-	$5^2/_3$	11,7172	3,9717	2,5458
37	74	North Atlantic	47° 30′	47° 30′	-	Chall. Rep.	-	$5^2/_3$	7,1058	3,9439	4,3475
38	-	—	-	42° 30′	-	Chall. Rep.	-	$5^2/_3$	10,0556	3,8282	3,5093
39	-	—	-	37° 30′	-	Chall. Rep.	-	$5^2/_3$	12,2222	3,7976	2,9537
40	-	—	-	32° 30′	-	Chall. Rep.	-	$5^2/_3$	13,1111	3,9028	2,6019
41	-	—	-	27° 30′	-	Chall. Rep.	-	$5^2/_3$	13,4492	3,8867	2,3390
42	-	—	-	22° 30′	-	Chall. Rep.	-	$5^2/_3$	13,7222	4,0328	2,2778
43	-	—	-	17° 30′	-	Chall. Rep.	-	$5^2/_3$	13,9444	4,0000	2,1852
44	75	—	-	12° 30′	-	Chall. Rep.	-	$5^2/_3$	14,0067	3,6113	2,4033
45	98	North Atlantic	42° 30′	67° 30′	-	Chall. Rep.	-	$5^2/_3$	8,4444	4,0970	6,2778
46	-	—	-	62° 30′	-	Chall. Rep.	-	$5^2/_3$	10,2408	3,9780	5,7675
47	-	—	-	57° 30′	-	Chall. Rep.	-	$5^2/_3$	11,6111	3,8844	5,2870
48	-	—	-	52° 30′	-	Chall. Rep.	-	$5^2/_3$	12,0000	4,0000	4,8148
49	76	—	-	47° 30′	-	Chall. Rep.	-	$5^2/_3$	12,9017	3,9261	4,1735
50	-	—	-	42° 30′	-	Chall. Rep.	-	$5^2/_3$	15,0467	3,7389	3,5758
51	-	—	-	37° 30′	-	Chall. Rep.	-	$5^2/_3$	16,0000	4,0723	3,1296
52	-	—	-	32° 30′	-	Chall. Rep.	-	$5^2/_3$	16,5000	3,9091	2,7870
53	-	—	-	27° 30′	-	Chall. Rep.	-	$5^2/_3$	16,6111	3,9028	2,6018
54	-	—	-	22° 30′	-	Chall. Rep.	-	$5^2/_3$	16,5750	4,2574	2,5510
55	-	—	-	17° 30′	-	Chall. Rep.	-	$5^2/_3$	16,3889	3,5200	2,4444
56	77	—	-	12° 30′	-	Chall. Rep.	-	$5^2/_3$	16,3067	3,4526	2,8617
57	102	North Atlantic	37° 30′	72° 30′	-	Chall. Rep.	-	$5^2/_3$	14,4300	3,9293	5,8283
58	-	—	-	67° 30′	-	Chall. Rep.	-	$5^2/_3$	16,1667	4,0081	4,5648
59	-	—	-	62° 30′	-	Chall. Rep.	-	$5^2/_3$	17,1111	4,1111	4,1111
60	-	—	-	57° 30′	-	Chall. Rep.	-	$5^2/_3$	17,6983	4,1183	3,7900
61	-	—	-	52° 30′	-	Chall. Rep.	-	$5^2/_3$	17,8889	4,1522	3,5370
62	81	—	-	47° 30′	-	Chall. Rep.	-	$5^2/_3$	18,0275	4,3098	3,2920
63	-	—	-	42° 30′	-	Chall. Rep.	-	$5^2/_3$	18,5000	4,3117	3,0741
64	-	—	-	37° 30′	-	Chall. Rep.	-	$5^2/_3$	18,9542	4,2096	2,9632
65	-	—	-	32° 30′	-	Chall. Rep.	-	$5^2/_3$	19,0000	4,1286	2,6759
66	-	—	-	27° 30′	-	Chall. Rep.	-	$5^2/_3$	18,8333	3,9306	2,6204
67	-	—	-	22° 30′	-	Chall. Rep.	-	$5^2/_3$	18,6111	4,0300	2,5000
68	-	—	-	17° 30′	-	Chall. Rep.	-	$5^2/_3$	18,1608	4,3107	2,3560
69	82	—	-	12° 30′	-	Chall. Rep.	-	$5^2/_3$	17,8817	3,8596	2,7583
70	106	North Atlantic	32° 30′	77° 30′	-	Chall. Rep.	-	$5^2/_3$	18,2778	3,9246	5,3056
71	-	—	-	72° 30′	-	Chall. Rep.	-	$5^2/_3$	20,7350	4,0176	3,8200

No.	No. in Tab. IX	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		M	$\Sigma(+Qm)$	MV
							years	number of years	°C		°C
	1	2	3	4	5	6	7	8	9	10	11
72	-	North Atlantic	32° 30′	67° 30′	-	Chall. Rep.	-	$5^2/_3$	+21,2778	3,9674	3,3796
73	-	—	-	62° 30′	-	Chall. Rep.	-	$5^2/_3$	21,3889	3,9783	3,0556
74	-	—	-	57° 30′	-	Chall. Rep.	-	$5^2/_3$	21,4444	3,8394	2,8800
75	-	—	-	52° 30′	-	Chall. Rep.	-	$5^2/_3$	21,4033	4,2995	2,7350
76	85	—	-	47° 30′	-	Chall. Rep.	-	$5^2/_3$	21,3050	4,3081	2,6100
77	-	—	-	42° 30′	-	Chall. Rep.	-	$5^2/_3$	21,2778	4,3968	2,5648
78	-	—	-	37° 30′	-	Chall. Rep.	-	$5^2/_3$	21,2778	4,6250	2,3981
79	-	—	-	32° 30′	-	Chall. Rep.	-	$5^2/_3$	21,0825	4,5409	2,2912
80	-	—	-	27° 30′	-	Chall. Rep.	-	$5^2/_3$	20,7778	4,3214	2,2407
81	-	—	-	22° 30′	-	Chall. Rep.	-	$5^2/_3$	20,4444	4,6863	2,2130
82	-	—	-	17° 30′	-	Chall. Rep.	-	$5^2/_3$	20,0000	4,6800	2,1667
83	86	—	-	12° 30′	-	Chall. Rep.	-	$5^2/_3$	20,0142	4,4667	2,3048
84	109	North Atlantic	27° 30′	77° 30′	-	Chall. Rep.	-	$5^2/_3$	23,4033	-	-
85	87	—	-	47° 30′	-	Chall. Rep.	-	$5^2/_3$	23,2867	-	-
86	88	—	-	22° 30′	-	Chall. Rep.	-	$5^2/_3$	21,8650	-	-
87	111	North Atlantic	22° 30′	72° 30′	-	Chall. Rep.	-	$5^2/_3$	+25,7275	-	-

TABLE VIII.

PROSPECT OF THERMO-GEOGRAPHICAL ELEMENTS, DERIVED FROM ACTUAL OBSERVATIONS AT 53 PLACES IN NORTH-AMERICA AND THE WEST-INDIES.

M denotes the observed mean yearly temperature,

$\Sigma\,(+Q'm)$ the statistically ascertained value of the dynamo-cosmical factor $\Sigma\,(+Qm)$, and

MV the thermo-geographical coefficient.

No.	No. in Tab. IX	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		M °C	$\Sigma (+Q'm)$	MV °C
							years	number of years			
	1	2	3	4	5	6	7	8	9	10	11
1	-	Boothia Felix	69° 59′	92° 1′	-	Dove	bef. 1848	$2^1/_2$	−15,7188	3,7870	13,1563
2	-	Fort Franklin	65° 12′	123° 13′	72	Dove	bef. 1848	$1^3/_4$	− 8,2396	4,1926	13,5313
3	-	St. Michaels	63° 48′	161° 0′	10	Chall. Rep.	1872—86	14	− 2,9825	3,7400	9,4075
4	93	Nain	57° 10′	61° 50′	-	Dove	bef. 1848	6	− 2,3473	4,1950	8,7458
			56° 33′	61° 41′	4	Chall. Rep.	1882—85	$3^1/_3$	− 5,7258	4,2220	10,2075
			56° 33′	61° 41′	4	Deutsche Seew.	1884—87	4	− 5,4328	4,3103	9,9445
5	-	St. Pauls Island	57° 7′	170° 18′	18	Chall. Rep.	1869—76	6	+ 1,6667	4,0374	4,0000
6	-	Sitka	57° 3′	135° 18′	-	Dove	bef. 1848	2	+ 7,4646	4,0147	4,3396
			57° 3′	135° 19′	5	Chall. Rep.	1832—76	43	+ 6,2642	3,8871	4,4025
7	-	York Factory	57° 2′	92° 28′	17	Chall. Rep.	1875—84	10	− 6,8325	3,7134	14,3042
8	-	Ilinlik Harbour	53° 52′	166° 31′	5	Chall. Rep.	1827—73	9	+ 3,6111	3,5128	3,8056
9	94	Belle Isle	51° 53′	55° 22′	122	Chall. Rep.	1882—84	$2^1/_3$	− 0,7408	3,6084	7,2875
10	95	Moose Factory	51° 15′	80° 45′	10	Chall. Rep.	1857—80	24	− 1,5525	4,0026	11,4492
11	-	Qu'Appelle	50° 44′	103° 42′	645	Chall. Rep.	1883—88	$5^1/_2$	− 0,2222	4,3581	12,5092
12	-	Medicine Hat	50° 1′	110° 37′	651	Chall. Rep.	1883—88	$5^1/_2$	+ 4,4444	4,0495	10,6111
13	-	Winnepeg	49° 55′	97° 7′	226	Chall. Rep.	1871—84	14	0,3967	4,1758	12,9055
14	-	Anticosti W. P.	49° 52′	64° 30′	-	Chall. Rep.	1870—84	15	1,8889	3,9091	8,3611
15	-	Anticosti S. W. P.	49° 24′	63° 16′	6	Chall. Rep.	1870—84	15	1,8889	3,9312	7,9352
16	-	Fort Vancouver	48° 37′	122° 37′	-	Dove	bef. 1848	1	10,9646	3,7518	4,9541
17	96	St. Johns, N. F.	47° 34′	52° 42′	46	Chall. Rep.	1870—84	15	4,9808	3,8117	6,2125
18	-	Olympia	47° 3′	122° 53′	10	Chall. Rep.	1870—84	15	9,8617	3,5263	4,2600
19	97	Quebec	46° 48′	71° 17′	-	Dove	bef. 1848	-	5,4698	3,5862	10,4781
			46° 48′	71° 12′	95	Chall. Rep.	1870—84	15	3,7222	3,9676	10,2130
20	-	Bismarck	46° 47′	100° 36′	516	Chall. Rep.	1874—84	$10^1/_4$	4,0608	3,9620	11,0407
21	-	Fredericton	45° 57′	66° 38′	18	Chall. Rep.	1870—84	15	4,4444	3,9300	9,3519
22	-	Montreal	45° 31′	73° 33′	57	Chall. Rep.	1870—84	15	6,0000	4,0518	10,1296
23	-	St. Pauls	44° 58′	93° 3′	244	Chall. Rep.	1870—84	15	6,6058	4,0589	10,4882
24	-	Halifax	44° 39′	63° 36′	37	Chall. Rep.	1870—84	15	+ 5,8750	3,9693	7,5050
25	-	Mount Washington	44° 16′	71° 18′	1914	Chall. Rep.	1872—84	13	− 3,3889	4,0365	8,1252
26	-	Toronto	43° 29′	79° 23′	107	Chall. Rep.	1870—84	15	+ 6,5556	3,9508	8,9260
27	-	Concorde	43° 12′	71° 29′	-	Dove	bef. 1848	10	6,9469	3,9337	8,2219
28	-	Albany	42° 39′	73° 44′	39	Dove	bef. 1848	18	9,0021	3,8215	8,4375
			42° 39′	73° 45′	23	Chall. Rep.	1870—84	15	9,0556	3,9470	8,9537
29	-	Boston	42° 21′	71° 4′	43	Chall. Rep.	1870—84	15	9,1283	3,7791	8,0000
30	99	Chicago	41° 52′	87° 38′	201	Chall. Rep.	1870—84	15	9,6475	3,9055	8,5092
31	-	Council Bluffs	41° 25′	95° 43′	239	Dove	bef. 1848	5	10,6541	4,0634	9,8598
32	-	Omaha	41° 16′	95° 56′	339	Chall. Rep.	1870—84	15	9,9275	3,9117	9,5396
33	-	Salt Lake City	40° 46′	111° 54′	1326	Chall. Rep.	1874—84	$10^3/_4$	10,8192	3,4265	7,8758
34	100	New York	40° 43′	74° 1′	-	Dove	bef. 1848	1	10,8541	3,9116	7,8369
			40° 43′	74° 0′	50	Chall. Rep.	1870—84	15	+10,7778	3,9144	8,0463

No.	No. in Tab. IX	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		M	$\Sigma (+ Q'm)$	MV
							years	number of years	°C		°C
	1	2	3	4	5	6	7	8	9	10	11
35	-	Pittsburg	40° 32′	80° 2′	233	Chall. Rep.	1870—84	15	+11,3692	3,9474	7,9808
36	-	Marietta	39° 25′	81° 30′	-	Dove	bef. 1848	18	11,3541	3,7847	7,1250
37	-	Washington	38° 54′	77° 2′	32	Chall. Rep.	1870—84	15	12,9725	3,6588	7,9808
38	-	Sacramento	38° 35′	121° 30′	20	Chall. Rep.	1870—84	15	15,5556	3,7970	4,6860
39	-	Fort Ross	38° 34′	122° 59′	-	Dove	bef. 1848	4	11,5844	4,0644	1,9073
40	101	St. Louis	38° 36′	89° 36′	-	Dove	bef. 1848	7	12,8605	3,7590	7,9815
			38° 27′	90° 12′	174	Chall. Rep.	1870—84	15	13,0883	3,9421	8,3384
41	-	San Francisco	37° 48′	122° 26′	18	Chall. Rep.	1870—84	15	13,1525	5,8661	1,5325
42	103	Cairo	37° 0′	89° 10′	115	Chall. Rep.	1870—84	15	14,3517	3,8505	7,6163
43	-	Santa Fé	35° 41′	105° 57′	2167	Chall. Rep.	1870—82	13	9,1742	3,8706	7,2675
44	104	Cape Hatteras	35° 14′	75° 30′	2	Chall. Rep.	1870—84	15	16,2108	3,7606	6,0792
45	-	Memphis	35° 9′	90° 3′	10	Chall. Rep.	1870—84	15	16,2100	3,8769	7,0817
46	105	Charleston	32° 49′	79° 56′	15	Chall. Rep.	1870—84	15	19,0592	3,7513	5,7275
47	-	San Diego	32° 43′	117° 10′	20	Chall. Rep.	1870—84	15	15,8183	4,0234	2,6900
48	108	New Orleans	29° 58′	90° 7′	-	Dove	bef. 1848	3	21,0010	4,5426	5,2240
			29° 58′	90° 4′	16	Chall. Rep.	1870—84	15	20,6408	4,0294	4,9825
49	-	St. Augustine	29° 50′	81° 27′	-	Dove	bef. 1848	4	22,2928	4,2132	4,1656
50	-	Galveston	29° 18′	94° 47′	12	Chall. Rep.	1870—84	15	21,0242	4,1653	5,3841
51	-	Punta Rassa	26° 29′	82° 1′	4	Chall. Rep.	1870—84	15	23,2217	4,3658	3,1566
52	110	Havana	23° 9′	82° 13′	-	Dove	bef. 1848	7	25,0917	-	-
			23° 8′	82° 23′	19	Chall. Rep.	1858—76	19	25,7975	-	-
53	112	St. Croix	17° 44′	64° 49′	-	Dove	bef. 1848	$1^1/_3$	27,2208	-	-
		(Christiansted)	17° 45′	64° 42′	25	Chall. Rep.	1877—85	9	27,1850	-	-
			17° 45′	64° 42′	25	Met. Inst.. Coph.	1887	1	27,1417	-	-
			17° 45′	64° 42′	25	Met. Inst., Coph.	1889	1	+27,4250	-	-

TABLE IX.

COMPARISON OF THE ACTUALLY OBSERVED AND CALCULATED MEAN YEARLY AND MONTHLY TEMPERATURE OF 112 PLACES, SITUATED IN THE ATLANTIC MIDDLE-ZONES OF THE NORTHERN HEMISPHERE.

No.	Section	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		Mean yearly temperat., $= M$	Calcut. yearly temp. composed of			$\Sigma\,(+\,Q'm)$
							years	number of years		temp. at sea-level: normal temperat. at lat. φ $= T\varphi$	temp. at sea-level: thermo-geographical component $= t\varphi,\lambda$	correction for Height, 0,50 °C per 100 m.	
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	I	Vardö	70° 22′	31° 7′	10	Chall. Rep.	1870—84	15	+0,4625				3,5665
			70° 22′	31° 7′	10	Formulæ	normal	-	−1,2059	−8,9882	+7,8323	−0,0500	3,8874
2	I	Kola	68° 53′	33° 1′	10	Chall. Rep.	1870—84	15	−0,5242				3,4055
			68° 53′	33° 1′	10	Formulæ	normal	-	−0,8183	−7,9026	+7,1343	−0,0500	3,8884
3	I	Stensele	65° 5′	17° 0′	337	Chall. Rep.	1870—84	15	+0,1075				3,5093
			65° 5′	17° 0′	337	Formulæ	normal	-	+1,3638	−5,0755	+8,1243	−1,6850	3,8874
								or	−0,3212	−5,0755	+8,1243	−3,3700	3,8874
4	I	Archangel	64° 32′	40° 33′	-	Dove	bef. 1848	18	+0,8483				3,5516
			64° 33′	40° 32′	5	Chall. Rep.	1870—84	15	0,0592				3,5121
			64° 33′	40° 32′	5	Formulæ	normal	-	0,1894	−4,6744	+4,8638	-	3,8874
5	I	Bergen	60° 24′	5° 18′	-	Dove	bef. 1848	6	8,2074				3,5900
			60° 24′	5° 20′	18	Chall. Rep.	1870—84	15	6,7317				3,5528
			60° 24′	5° 20′	18	Formulæ	normal	-	7,1942	−1,5296	+8,8138	−0,0900	3,8874
6	I	St. Petersburg	59° 56′	30° 18′	-	Dove	bef. 1848	13	4,2249				3,6453
			59° 56′	30° 18′	-	Dove	bef. 1848	10	2,5750				3,5042
			59° 56′	30° 16′	6	Chall. Rep.	1870—84	15	3,7458				3,8333
			59° 56′	30° 16′	6	Formulæ	normal	-	3,5223	−1,1741	+4,6964	-	3,8874
7	I	Christiania	59° 55′	10° 43′	23	Dove	bef. 1848	15	5,1818				3,7053
			59° 55′	10° 43′	25	Chall. Rep.	1870—84	15	5,3017				3,6452
			59° 55′	10° 43′	25	Mohn	-	33	5,1333				3,7369
			59° 55′	10° 43′	25	Formulæ	normal	-	6,9662	−1,1614	+8,2526	−0,1250	3,8874
8	I	Stockholm	59° 21′	18° 4′	40	Dove	bef. 1848	15	5,7063				3,4816
			59° 21′	18° 4′	40	Dove	bef. 1848	50	5,6250				3,5115
			59° 20′	18° 4′	44	Chall. Rep.	1870—84	15	5,3608				3,4384
			59° 20′	18° 4′	44	Formulæ	normal	-	5,4286	−0,7170	+6,3656	−0,2200	3,8874
9	I	Göteborg	57° 41′	11° 56′	-	Dove	bef. 1848	45	7,9261				3,9504
			57° 42′	11° 59′	7	Chall. Rep.	1870—84	15	7,1100				3,6060
			57° 42′	11° 59′	7	Formulæ	normal	-	7,2256	+0,5409	+6,7197	−0,0350	3,8874
10	I	Libau	56° 31′	21° 1′	6	Chall. Rep.	1870—84	15	6,2717				3,6308
			56° 31′	21° 1′	6	Formulæ	normal	-	6,2942	+1,4299	+4,8943	−0,0300	3,8874
11	I	Moscow	55° 45′	37° 38′	125	Dove	bef. 1848	21	4,4562				3,8338
			55° 50′	37° 33′	155	Chall. Rep.	1870—84	15	3,9067				3,6805
			55° 50′	37° 33′	155	Formulæ	normal	-	3,8120	+1,9501	+2,6369	−0,7750	3,8874
12	I	Copenhagen	55° 41′	12° 35′	-	Dove	bef. 1848	45	8,0885				3,8156
			55° 41′	12° 35′	-	Dove	bef. 1848	63	7,6553				3,8912
			55° 41′	12° 36′	14	Chall. Rep.	1870—84	15	7,4167				3,6954
			55° 41′	12° 36′	14	Met. Inst.., Coph.	1887—91	5	7,3017				3,9275
			55° 41′	12° 36′	14	V. Willaume-Jantzen	1861—94	34	7,4226				3,7344
			55° 41′	12° 36′	14	Formulæ	normal	-	+7,8800	+2,0642	+5,8858	−0,0700	3,8874

	MV	Amplitude	Class of climate	Jan. °C	Feb. °C	March °C	April °C	May °C	June °C	July °C	August °C	Septb. °C	Octb. °C	Novbr. °C	Decbr. °C
14	**15**	**16**		**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
4,7125	14,83			— 5,06	— 6,11	— 4,72	— 2,00	1,11	5,33	8,39	8,72	5,89	1,61	— 2,50	— 5,11
4,7100	15,050	III		— 8,986	— 7,584	— 5,548	— 1,723	2,019	4,623	6,064	5,495	3,129	— 0,305	— 4,156	— 7,499
7,8008	25,000			—10,56	—11,78	— 6,94	— 2,06	3,11	9,61	13,22	11,89	6,11	— 0,28	— 7,83	—10,78
7,8000	24,923	IV		—13,703	—11,380	— 8,010	— 1,674	4,522	8,834	11,221	10,279	6,361	0,674	— 5,703	—11,239
8,7458	26,89			—11,44	—11,83	— 6,50	— 0,56	5,39	11,89	15,06	12,39	6,89	0,50	— 7,61	—12,89
8,7500	27,959	IV		—13,090	—10,484	— 6,703	0,403	7,354	12,192	14,869	13,813	9,417	3,037	— 4,116	—10,327
8,7500	27,959	IV		—14,775	—12,169	— 8,388	— 1,282	5,669	10,507	13,184	12,128	7,732	1,352	— 5,801	—12,012
8,9750	30,13			—14,12	—12,65	— 5,61	— 0,34	5,38	12,87	16,01	14,21	8,68	1,79	— 5,21	—10,83
9,3842	29,50			—13,50	—13,17	— 7,89	— 2,33	4,72	12,61	16,00	13,83	7,89	1,61	— 6,39	—12,67
9,1600	29,269	V		—14,942	—12,214	— 8,256	— 0,816	+ 6,461	11,525	14,328	13,222	8,620	1,941	— 5,547	—12,049
4,5281	14,10			1,675	2,575	3,100	6,850	10,738	13,638	15,775	14,925	12,425	8,912	4,938	2,938
4,7300	14,55			1,11	0,17	1,61	5,39	8,78	12,94	14,72	14,22	11,28	6,83	3,06	0,67
4,6600	14,890	III		— 0,504	0,884	2,898	6,683	10,385	12,961	14,387	13,824	11,483	8,086	4,276	0,968
8,2020	27,31			— 9,588	— 7,400	— 3,612	2,875	9,175	15,525	17,725	16,200	10,725	5,212	— 0,900	— 5,238
8,7750	28,10			—10,500	— 9,300	— 7,000	1,500	7,100	14,400	17,600	16,000	9,800	3,200	— 4,600	— 7,300
8,3575	26,22			— 8,22	— 8,61	— 4,33	1,72	8,28	15,50	17,61	15,78	10,89	4,56	— 1,06	— 7,17
8,4450	27,517	IV		—10,703	— 8,138	— 4,417	2,577	9,418	14,179	16,814	15,775	11,448	5,169	— 1,871	— 7,983
6,9005	21,850			— 5,494	— 4,369	— 1,081	4,056	9,362	14,494	16,356	15,012	11,188	5,738	0,344	— 3,425
7,1750	21,72			— 4,28	— 4,61	— 1,50	4,00	9,78	15,61	17,11	15,78	11,22	5,06	0,06	— 4,61
7,0833	21,60			— 5,1	— 5,0	— 1,8	3,8	9,9	14,8	16,5	15,3	11,3	5,5	— 0,1	— 3,5
7,0600	22,559	IV		— 4,696	— 2,594	+ 0,457	6,191	11,799	15,703	17,863	17,011	13,464	8,316	+ 2,544	— 2,466
6,8292	21,750			— 4,275	— 2,962	— 1,338	2,650	9,038	13,900	17,475	16,000	12,025	6,775	1,875	— 2,688
7,0083	22,200			— 4,600	— 3,800	— 2,100	3,500	9,100	14,700	17,600	16,600	11,500	6,300	1,300	— 2,600
6,4808	19,95			— 2,61	— 3,28	— 1,61	2,61	7,94	14,11	16,67	15,28	11,44	5,61	0,89	— 2,72
6,8700	21,952	IV		— 5,920	— 3,874	— 0,905	4,675	10,132	13,929	16,032	15,203	11,753	6,743	1,126	— 3,750
6,1883	18,450			— 1,125	— 1,050	1,200	6,575	11,675	16,125	17,325	16,825	13,275	9,262	3,688	1,338
6,0100	18,28			— 0,39	— 1,17	0,72	5,00	10,22	15,00	17,11	16,28	12,72	7,39	3,00	— 0,56
6,1000	19,492	IV		— 2,851	— 1,034	1,602	6 ,557	11,402	14,774	16,641	15,905	12,840	8,392	3,405	— 0,924
6,6250	20,39			— 2,78	— 3,17	— 0,28	4,06	8,44	14,78	17,22	16,61	13,22	7,11	2,11	— 2,06
6,6300	21,185	IV		— 4,658	— 2,683	+ 0,182	5,567	10,833	14,499	16,527	15,727	12,396	7,562	2,142	— 2,564
9,3647	29,350			—10,238	— 8,888	— 2,912	5,400	12,475	16,875	19,112	17,288	11,775	4,162	— 2,700	— 8,875
9,2583	29,500			—10,50	—10,28	— 4,61	2,89	11,61	17,33	19,00	16,39	10,44	4,22	— 1,39	— 8,22
9,3115	29,753	V		—11,570	— 8,797	— 4,773	2,790	10,187	15,335	18,184	17,060	12,382	5,593	— 2,020	— 8,629
6,2637	19,463			— 1,525	— 0,813	1,663	6,075	11,488	15,900	17,938	17,325	13,937	9,525	4,362	1,187
6,2302	18,712			— 1,450	— 1,000	0,688	5,562	11,225	15,563	17,262	16,875	13,575	8,813	3,900	0,850
5,7300	17,44			+ 0,06	— 0,72	1,39	5,61	9,89	14,67	16,72	16,22	12,94	8,44	3,72	0,06
5,7217	16,80			— 0,30	— 0,76	0,26	4,66	10,96	14,78	16,04	15,20	12,76	8,40	4,32	1,30
5,7441	17,246			— 0,585	— 0,333	1,079	5,690	10,492	15,010	16,661	15,920	12,794	8,062	3,624	0,659
5,7311	18,313	III		— 1,587	+ 0,120	2,596	7,251	11,813	14,972	16,726	16,034	13,155	8,976	4,291	0,223

No.	Section	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		Mean yearly temperat., $= M$	Calcut. yearly temp. composed of			$\Sigma (+ Q'm)$
							years	number of years		temp. at sea-level: normal temperat. at lat. $\varphi = T\varphi$	temp. at sea-level: thermo-geographical component $= t\varphi,\lambda$	correction for Height, 0,50 °C per 100 m.	
	1	2	3	4	5	6	7	8	9	10	11	12	13
13	I	Fanö (Esbjerg)	55° 27′	8° 24′	6	Chall. Rep.	1870—84	15	+ 7,6675				3,7195
			55° 27′	8° 24′	6	Met. Inst., Cophg.	1887—91	5	7,305				4,3125
			55° 27′	8° 24′	6	Formulæ	normal	-	8,6910	+2,2417	+6,4793	−0,0300	3,8874
14	I	Samara	54° 19′	48° 0′	60	Chall. Rep.	1870—84	15	3,4950				4,1176
			54° 19′	48° 0′	60	Formulæ	normal	-	4,0725	+3,1025	+1,2700	−0,3000	3,8874
15	I	Hamburg	53° 33′	9° 58′	-	Dove	bef. 1848	18	8,9073				3,9196
			53° 33′	9° 58′	19	Chall. Rep.	1870—84	15	8,3889				3,6442
			53° 33′	9° 59′	26	Deutsche Seewarte	1876—85	10	8,2100				3,7015
			53° 33′	9° 59′	26	do.	1886—90	5	7,6808				4,2973
			53° 33′	9° 59′	26	Formulæ	normal	-	8,9784	+3,6834	+5,4250	−0,1300	3,8874
16	I	Orel	52° 57′	36° 7′	170	Chall. Rep.	1833—68	28	4,6475				3,8361
			52° 57′	36° 7′	170	Formulæ	normal	-	5,2706	+4,1369	+1,9837	−0,8500	3,8874
17	I	Berlin	52° 30′	13° 24′	31	Dove	bef. 1848	24	8,9783				3,9396
			52° 30′	13° 23′	41	Chall. Rep.	1870—84	15	9,1667				3,6151
			52° 30′	13° 23	41	Formulæ	normal	-	8,7798	+4,4764	+4,5084	−0,2050	3,8874
18	I	Amsterdam	52° 23′	4° 53′	-	Dove	bef. 1848	12	9,9200				3,9675
			52° 22′	4° 53′	9	Chall. Rep.	1870—84	15	9,4583				3,6360
			52° 22′	4° 53′	9	Formulæ	normal	-	10,1226	+4,5769	+5,5907	−0,0450	3,8874
19	I	Warsaw	52° 13′	21° 2′	120	Chall. Rep.	1870—84	15	7,3950				3,6394
			52° 13′	21° 2′	120	Formulæ	normal	-	7,5347	+4,6900	+3,4447	−0,6000	3,8874
20	I	London-Greenwich	51° 30′	0° 0′	48	Dove	bef. 1848	10	10,3458				3,9016
			51° 30′	0° 0′	48	Dove	bef. 1848	49	10,4646				3,8077
			51° 30′	0° 0′	48	Dove	bef. 1848	3	9,4154				4,4977
			51° 30′	0° 0′	48	Chall. Rep.	1870—84	15	10,1533				3,6789
			51° 30′	0° 0′	48	Formulæ I	normal	-	10,7251	+5,2289	+5,7362	−0,2400	3,8874
			51° 30′	0° 0′	48	Formulæ V	normal	-	10,4706	+5,2289	+5,4817	−0,2400	3,8874
			51° 30′	0° 0′	48	Formulæ I-V	normal	-	10,5978	+5,2289	+5,6089	−0,2400	3,8874
21	I	Frankfort	50° 10′	8° 37′	104	Dove	bef. 1848	20	9,7992				3,9102
			50° 10′	8° 37′	104	Dove	bef. 1848	30	9,7275				3,9014
			50° 10′	8° 37′	104	Physik. Verein	1837—56	20	9,5535				3,9742
			50° 10′	8° 37′	104	Greis-Meerman	normal	20	9,5559				3,9338
			50° 10′	8° 37′	104	Formulæ	normal	-	9,7181	+6,2265	+4,0116	−0,5200	3,8874
22	II	Paris	48° 50′	2° 20′	36	Dove	bef. 1848	39	10,7281				3,9287
			48° 50′	2° 21′	78	Chall. Rep.	1870—84	15	10,4683				3,4956
			48° 50′	2° 21′	78	M. E. Renou	1761-1880	120	10,6350				3,8804
			48° 50′	2° 21′	78	Formulæ II	normal	-	11,6560	+7,2414	+4,8046	−0,3900	3,8874
			48° 50′	2° 21′	78	Formulæ I-II	normal	-	+11,1375	+7,2414	+4,2861	−0,3900	3,8874

	MV	Amplitude	Class of climate	Jan. °C	Feb. °C	March °C	April °C	May °C	June °C	July °C	August °C	Septb. °C	Octb. °C	Novbr. °C	Decbr. °C
14	**15**	**16**		**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
5,4075	16,17			+ 0,56	+ 0,22	2,06	6,00	10,17	14,00	16,39	16,17	13,22	8,50	3,94	0,78
5,5883	15,60			— 0,20	— 0,52	0,74	4,72	11,14	14,58	15,08	14,76	13,06	8,74	4,32	1,24
5,4500	17,415		III	— 0,312	+ 1,311	5,666	8,093	12,422	15,435	17,103	16,445	13,707	9,733	5,278	1,410
11,4025	34,05			—13,94	—13,50	— 7,17	3,72	13,67	18,22	20,11	18,00	11,33	4,11	— 2,83	— 9,78
11,4000	36,427		VI	—14,759	—11,364	— 6,438	2,821	11,877	18,180	21,668	20,292	14,565	6,253	— 3,067	—11,158
6,0219	19,238			— 1,113	+ 1,338	3,363	8,175	13,800	16,750	18,125	17,988	13,988	8,925	4,575	+ 0,975
5,5000	16,833			+ 0,611	+ 1,167	3,556	7,333	11,167	15,444	17,444	16,889	13,667	8,722	4,000	+ 0,667
5,5153	17,53			— 0,38	+ 1,80	2,92	7,37	11,12	15,60	17,15	16,44	13,49	8,54	3,67	+ 0,80
5,9725	17,55			— 0,71	— 1,53	1,52	6,85	12,79	15,63	16,02	15,80	13,57	8,11	4,22	— 0,10
5,7500	18,373		III	— 0,520	+ 1,192	3,677	8,347	12,915	16,094	17,853	17,159	14,271	10,078	5,377	+ 1,296
9,3875	29,66			—10,33	— 9,39	— 4,89	4,94	13,11	17,33	19,33	17,67	11,83	4,56	— 1,00	— 7,39
9,3900	30,004		V	—10,241	— 7,444	— 3,387	4,240	11,699	16,891	19,764	18,631	13,913	7,067	— 0,610	— 7,275
6,4492	21,175			— 2,375	— 0,188	3,425	8,600	13,650	17,425	18,800	18,038	14,688	9,964	4,062	1,650
6,0933	18,84			+ 0,44	+ 0,89	3,89	8,39	12,61	17,17	19,28	18,28	14,83	9,39	4,39	0,44
6,2700	20,035		IV	— 1,578	+ 0,290	2,999	8,092	13,072	16,539	18,457	17,701	14,551	9,979	4,853	0,403
5,6933	17,87			0,66	2,67	4,85	8,96	13,16	16,95	18,53	18,50	15,90	10,64	5,51	2,71
4,9400	15,17			2,44	3,11	4,67	8,11	11,28	15,28	17,61	17,33	14,78	10,11	5,72	3,06
5,2800	16,871		III	1,401	2,973	5,255	9,543	13,737	16,657	18,272	17,635	14,982	11,133	6,816	3,068
7,2092	22,61			— 3,33	— 2,83	1,06	6,94	12,28	17,61	19,28	17,56	13,50	7,22	2,17	— 2,72
7,2100	23,038		IV	— 4,375	— 2,228	0,887	6,743	12,471	16,457	18,663	17,793	14,171	8,914	3,019	— 2,098
4,6520	15,000			2,775	4,725	5,550	8,888	12,775	16,112	17,500	17,775	15,000	10,825	7,500	4,725
4,6708	14,850			2,975	4,762	6,250	9,125	13,075	16,150	17,825	17,588	15,075	11,100	6,888	4,762
4,4580	15,113			1,912	2,962	7,012	8,012	12,250	14,738	15,362	17,025	14,450	8,562	6,062	4,638
4,5417	13,78			3,78	4,67	5,72	9,00	12,22	15,78	17,56	17,39	14,72	10,50	6,11	4,39
4,6062	14,718		III	3,116	4,488	6,478	10,220	13,879	16,425	17,835	17,279	14,965	11,606	7,840	4,571
4,6062	14,718		III	2,862	4,233	6,224	9,965	13,624	16,171	17,580	17,024	14,710	11,352	7,586	4,317
4,6062	14,718		III	2,989	4,361	6,351	10,092	13,751	16,298	17,707	17,151	14,837	11,479	7,713	4,444
5,9507	19,23			— 0,30	2,60	5,30	9,50	14,30	17,50	18,93	18,74	15,23	9,57	4,97	1,25
6,1142	19,88			— 0,75	2,00	5,38	9,62	14,62	17,62	19,13	18,50	15,06	10,12	4,12	1,31
6,2783	19,443			— 0,411	1,147	4,028	9,379	14,214	17,946	19,032	18,815	14,900	10,085	4,729	0,778
6,1813	19,242			— 0,258	1,170	4,274	9,292	14,141	17,838	18,984	18,480	15,033	9,948	4,838	0,932
6,1100	19,524		IV	— 0,375	1,445	4,085	9,048	13,901	17,279	19,149	18,411	15,342	10,887	5,892	1,555
5,2200	16,788			1,912	4,188	6,662	9,875	14,488	17,075	18,700	18,525	15,650	11,250	6,672	3,650
4,9067	16,11			2,89	4,56	7,00	10,17	13,00	16,56	18,89	18,33	15,00	10,22	6,22	2,78
5,2483	16,55			2,20	4,21	6,33	10,12	13,93	17,10	18,75	18,70	15,74	11,08	6,27	3,19
5,2483	16,770		III	2,987	4,549	6,817	11,080	15,249	18,151	19,757	19,123	16,486	12,660	8,369	4,644
5,2483	16,770		III	2,468	4,031	6,299	10,562	14,731	17,632	19,238	18,605	15,968	12,141	7,851	4,126

No.	Section	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		Mean yearly temperat., $= M$	Calcul. yearly temp. composed of			$M + Q'm$
							years	number of years		temp. at sea-level: normal temperat. at lat $\varphi = T\varphi$	temp. at sea-level: thermo-geographical component $= t\varphi,\lambda$	correction for Height, 0,50 °C per 100 m.	
	1	2	3	4	5	6	7	8	9	10	11	12	13
23	II	Vienna	48° 13′	16° 23′	141	Dove	bef. 1848	60	+10,5688				3,9617
			48° 14′	16° 22′	202	Chall. Rep.	1870—84	15	9,3342				3,6497
			48° 14′	16° 22′	202	Formulæ	normal	-	9,8876	+ 7,6597	+3,2379	—1,0100	3,8874
24	II	Buda-Pest	47° 29′	19° 3′	254	Dove	bef. 1848	9	8,5983				4,1493
			47° 29′	19° 3′	254	Dove	bef. 1848	17	10,3167				4,1641
			47° 30′	19° 2′	153	Chall. Rep.	1870—84	15	9,9875				3,6972
			47° 30′	19° 2′	153	Formulæ	normal	-	10,3441	+ 8,1985	+2,9106	—0,7650	3,8874
25	II	Astrakhan	46° 21′	48° 8′	22	Dove	bef. 1848	-	10,0267				4,3888
			46° 21′	48° 2′	—21	Chall. Rep.	1870—84	15	9,8942				3,8085
			46° 21′	48° 2′	-	Formulæ	normal	-	9,7459	+ 9,0372	+0,7087	-	3,8874
26	II	Sebastopol	44° 36′	33° 32′	-	Dove	bef. 1848	10	11,6498				3,9939
			44° 37′	33° 31′	61	Chall. Rep.	1870—84	15	12,4544				3,6612
			44° 37′	33° 31′	61	Formulæ	normal	-	11,9015	+10,2860	+1,9205	—0,3050	3,8874
27	II	Bukharest	44° 27′	26° 8′	-	Dove	bef. 1848	2	7,9692				3,7484
			44° 25′	26° 5′	93	Chall. Rep.	1870—84	15	10,5425				3,8625
			44° 25′	26° 5′	93	Formulæ	normal	-	12,2936	+10,4287	+2,3299	—0,4650	3,8874
28	II	Montpellier	43° 36′	3° 53′	31	Dove	bef. 1848	11	15,2800				3,5759
			43° 37′	3° 53′	37	Chall. Rep.	1870—84	15	14,4025				3,5075
			43° 37′	3° 53′	37	Formulæ	normal	-	13,6114	+10,9969	+2,7995	—0,1850	3,8874
29	II	Rome	41° 54′	12° 25′	50	Dove	bef. 1848	20	15,8272				3,8715
			41° 54′	12° 29′	50	Chall. Rep.	1870—84	15	15,4858				3,5900
			41° 54′	12° 29′	50	Formulæ	normal	-	14,4838	+12,1995	+2,5343	—0,2500	3,8874
30	II	Constantinople	41° 0′	28° 59′	-	Chall. Rep.	1870—84	15	14,2308				3,8861
			41° 0′	28° 59′	-	Formulæ	normal	-	15,0371	+12,8202	+2,2169	-	3,8874
31	II	Athens	37° 58′	23° 44′	103	Chall. Rep.	1859—82	24	17,2775				3,7535
			37° 58′	23° 44′	103	Formulæ	normal	-	16,5575	+14,8571	+2,2154	—0,5150	3,8874
32	II	Algiers	36° 47′	3° 3′	-	Dove	bef. 1848	3½	17,9228				4,1585
			36° 47′	3° 4′	22	Chall. Rep.	1870—84	15	17,9492				3,6883
			36° 47′	3° 4′	22	Formulæ	normal	-	18,0351	+15,6266	+2,5185	—0,1100	3,8874
33	II	Malta	35° 53′	14° 30′	21	Chall. Rep.	1870—84	15	19,2267				3,8026
			35° 53′	14° 30′	21	Formulæ	normal	-	18,3852	+16,2016	+2,2886	—0,1050	3,8874
34	II	Bagdad	33° 21′	44° 22′	-	Dove	bef. 1848	1	23,1875				4,5843
			33° 21′	44° 26′	12	Chall. Rep.	1861—62	1	23,3375				4,1000
			33° 21′	44° 26′	12	Formulæ	normal	-	20,1458	+17,7694	+2,4364	—0,0600	3,8874
35	II	Tripolis	32° 53′	13° 11′	30	Chall. Rep.	1819—21	4	20,6300				4,4314
			32° 53′	13° 11′	30	Formulæ	normal	-	20,3379	+18,0497	+2,4382	—0,1500	3,8874
36	II	Jerusalem	31° 47′	35° 13′	732	Chall. Rep.	1863—81	19	17,2175				4,9546
			31° 47′	35° 13′	732	Formulæ	normal	-	+16,9847	+18,6992	+1,9455	—3,6600	3,8874

MV	Amplitude	Class of climate	Jan. °C	Feb. °C	March °C	April °C	May °C	June °C	July °C	August °C	Septb. °C	Octb. °C	Novbr. °C	Decbr. °C
14	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
7,2342	23,037		— 1,512	0,850	4,888	11,025	16,750	19,712	21,525	21,088	16,612	10,675	4,638	0,575
6,6583	21,61		— 1,33	0,22	4,61	9,50	13,67	17,89	20,28	18,89	15,06	10,00	3,72	— 0,50
6,9462	22,196	IV	— 1,587	0,482	3,484	9,125	14,643	18,484	20,609	19,771	16,281	11,216	5,537	0,607
7,3387	23,07		— 3,86	— 2,03	2,44	9,00	14,51	18,01	19,21	19,08	15,30	9,11	3,71	— 1,30
7,9000	23,60		— 1,90	+ 0,50	3,70	10,00	18,10	20,10	21,70	21,70	17,10	10,60	2,10	+ 0,10
7,2296	23,16		— 1,44	— 0,22	4,78	10,67	15,06	19,28	21,72	20,28	15,89	10,39	4,00	— 0,56
7,5400	24,093	IV	— 2,111	+ 0,134	3,393	9,517	15,506	19,675	21,982	21,072	17,284	11,786	5,622	+ 0,270
10,9305	36,11		—10,75	— 6,15	2,12	11,36	20,93	22,90	24,97	25,36	20,18	10,07	3,81	— 4,48
9,9758	31,94		— 6,33	— 6,00	0,39	9,78	18,39	23,50	25,61	23,89	17,50	10,33	3,78	— 2,11
9,9800	31,890	V	— 6,740	— 3,768	0,545	8,651	16,578	22,096	25,150	23,945	18,931	11,655	3,496	— 3,588
6,7230	20,488		1,262	2,512	5,762	10,512	16,412	21,162	21,750	21,375	17,450	12,088	6,712	2,800
6,6473	21,72		2,11	1,61	5,28	10,28	16,00	20,67	23,33	22,61	18,50	13,50	9,89	5,67
6,6900	21,377	IV	0,851	2,843	5,734	11,167	16,482	20,180	22,227	21,420	18,059	13,181	7,712	2,963
7,5725	26,59		— 4,45	— 6,50	— 0,15	6,85	13,51	16,98	20,09	18,42	14,61	9,64	6,03	+ 0,60
8,0904	26,22		— 3,11	— 2,11	+ 4,33	11,11	16,50	20,72	23,11	21,78	17,56	11,56	5,17	— 0,11
8,0900	25,850	IV	— 1,070	+ 1,339	+ 4,835	11,406	17,832	22,305	24,780	23,804	19,739	13,841	7,227	+ 1,485
6,2400	20,13		5,62	7,12	9,38	14,12	18,00	22,50	25,75	25,00	21,25	16,62	10,38	7,62
5,3192	17,28		6,28	8,33	10,11	13,11	16,44	20,22	23,50	23,56	20,00	14,61	10,00	6,67
5,7100	18,245	III	4,179	5,880	8,347	12,985	17,521	20,678	22,425	21,736	18,867	14,704	10,035	5,983
5,5478	17,187		7,238	8,525	10,925	14,338	18,475	21,725	24,425	24,250	21,150	18,225	11,875	8,775
5,5608	17,67		7,11	8,33	10,50	14,22	17,78	21,39	24,78	24,50	21,22	16,61	11,39	8,00
5,5500	17,734	III	5,316	6,969	9,367	13,875	18,283	21,352	23,050	22,380	19,592	15,545	11,008	7,069
5,8608	18,28		5,39	5,00	7,39	12,22	16,61	21,11	23,28	23,22	20,00	16,33	11,89	8,33
5,8600	18,725	III	5,357	7,102	9,634	14,394	19,049	22,289	24,082	23,375	20,431	16,158	11,367	7,208
6,0825	19,00		8,00	8,78	11,33	15,06	19,94	24,44	27,00	26,67	23,33	18,78	14,06	9,94
6,0800	19,438	IV	6,514	8,325	10,952	15,890	20,720	24,082	25,942	25,208	22,153	17,720	12,749	8,434
4,2292	13,062		11,650	12,675	13,325	15,025	19,075	21,950	24,025	24,712	22,875	20,275	16,625	12,862
4,1992	13,39		12,22	12,78	13,39	16,22	18,22	21,50	24,78	25,61	23,00	19,78	15,28	12,61
4,2100	13,452	III	11,081	12,334	14,154	17,573	20,917	23,245	24,533	24,025	21,910	18,840	15,398	12,410
4,2928	13,00		13,50	13,50	14,17	16,28	19,22	22,94	26,00	26,50	24,89	21,56	17,83	14,33
4,2900	13,708	III	11,299	12,576	14,430	17,914	21,322	23,694	25,007	24,489	22,334	19,206	15,698	12,654
8,2612	27,50		9,25	13,12	17,50	23,75	30,50	33,38	34,00	34,50	30,75	25,00	19,50	7,00
7,8942	25,17		9,72	13,61	17,00	23,11	30,72	32,78	34,89	34,11	30,11	24,78	18,22	11,00
8,0800	25,818	IV	6,799	9,205	12,696	19,259	25,678	30,145	32,617	31,642	27,582	21,691	15,085	9,351
4,0917	12,89		14,22	15,06	16,28	18,56	21,11	23,56	26,17	27,11	26,44	23,94	19,39	15,72
4,0900	13,067	III	13,583	14,800	16,567	19,889	23,138	25,399	26,651	26,157	24,102	21,120	17,776	14,874
5,0975	15,39		8,78	9,11	12,39	15,83	20,22	22,78	23,39	24,17	22,61	20,72	15,61	11,00
5,1000	16,296	III	8,560	10,079	12,283	16,425	20,476	23,296	24,856	24,241	21,679	17,960	13,791	10,171

No.	Section	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		Mean yearly temperat., $= M$	Calcul. yearly temp. composed of			$\Sigma (+ Q'm)$
							years	number of years		temp. at sea-level		correction for Height, 0,50 °C per 100 m.	
										normal temperat. at lat. φ $= T\varphi$	thermo-geographical component $= t\varphi,\lambda$		
	1	2	3	4	5	6	7	8	9	10	11	12	13
37	II	Alexandria	31° 12′	29° 53′	19	Chall. Rep.	1870—84	15	+20,5375				4,6294
			31° 12′	29° 53′	19	Formulæ	normal	-	+20,7921	+19,0372	+1,8499	—0,0950	3,8874
38	II	Kouka	13° 10′	14° 30′	275	Dove	bef. 1848	2	+28,746				-
			13° 10′	14° 30′	275	Formulæ	normal	-	+29,5812	+26,8300	+4,1262	—1,3750	-
39	III	Obdorsk	66° 31′	66° 35′	24	Chall. Rep.	1870—84	15	— 7,4542				3,2902
			66° 31′	66° 35′	24	Formulæ	normal	-	— 6,3629	— 6,1487	—0,0942	—0,1200	3,8874
40	III	Turuchansk	65° 55′	87° 38′	19	Chall. Rep.	1877—87	10½	— 7,6667				3,2064
			65° 55′	87° 38′	19	Formulæ	normal	-	— 8,7514	— 5,7004	—2,9560	—0,0950	3,8874
41	III	Ust-Syssolsk	61° 40′	50° 51′	100	Chall. Rep.	1817—67	51	+ 0,2825				3,5188
			61° 40′	50° 51′	100	Formulæ	normal	-	— 0,5914	— 2,4929	+2,4015	—0,5000	3,8874
42	III	Tobolsk	58° 12′	68° 16′	108	Chall. Rep.	1870—84	15	+ 0,7092				3,6539
			58° 12′	68° 16′	108	Formulæ	normal	-	— 1,1382	+ 0,1471	—0,7453	—0,5400	3,8874
43	III	Perm	58° 1′	56° 16′	100	Chall. Rep.	1870—84	15	+ 1,0375				3,5667
			58° 1′	56° 16′	100	Formulæ	normal	-	+ 0,5998	+ 0,2868	+0,8130	—0,5000	3,8874
44	III	Tomsk	56° 30′	85° 10′	91	Dove	bef. 1848	9	— 0,4267				3,5643
			56° 30′	85° 10′	91	Dove	bef. 1848	5	— 1,3692				3,7075
			56° 30′	84° 58′	77	Chall. Rep.	1870—84	15	— 0,5842				3,5951
			56° 30′	84° 58′	77	Formulæ	normal	-	— 1,0991	+ 1,4426	—2,1567	—0,3850	3,8874
45	III	Omsk	54° 58′	73° 20′	79	Chall. Rep.	1870—84	15	+ 0,1658				3,6772
			54° 58′	73° 20′	79	Formulæ	normal	-	+ 0,7652	+ 2,6091	—1,4489	—0,3950	3,8874
46	III	Barnaul	53° 20′	83° 27′	122	Dove	bef. 1848	6	— 0,4267				3,8910
			53° 20′	83° 47′	140	Chall. Rep.	1870—84	15	+ 0,8975				3,7821
			53° 20′	83° 47′	140	Formulæ	normal	-	+ 1,1656	+ 3,8472	—1,9816	—0,7000	3,8874
47	III	Orenburg	50° 46′	55° 6′	69	Dove	bef. 1848	8	+ 1,6983				3,8931
			51° 46′	55° 6′	91	Chall. Rep.	1870—84	15	+ 3,7375				4,0032
			51° 46′	55° 6′	91	Formulæ	normal	-	+ 4,4495	+ 5,0285	—0,1240	—0,4550	3,8874
48	III	Akmolinsk	51° 12′	71° 23′	306	Chall. Rep.	1870—84	15	+ 1,4808				3,8574
			51° 12′	71° 23′	306	Formulæ	normal	-	+ 2,2945	+ 5,4539	—1,6294	—1,5300	3,8874
49	III	Semipolatinsk	50° 24′	80° 13′	181	Chall. Rep.	1870—84	15	+ 2,8058				3,8356
			50° 24′	80° 13′	181	Formulæ	normal	-	+ 3,2112	+ 6,0524	—1,9362	—0,9050	3,8874

	MV	Amplitude	Class of climate	Jan. °C	Feb. °C	March °C	April °C	May °C	June °C	July °C	August °C	Septb. °C	Octb. °C	Novbr. °C	Decbr. °C
	14	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
	3,6592	11,62		14,44	14,61	16,22	18,89	21,17	23,89	25,28	26,06	25,22	23,56	20,28	16,83
	3,6600	11,695	II	14,746	15,836	17,418	20,390	23,298	25,321	26,441	26,000	24,161	21,492	18,500	15,902
	2,6283	11,35		24,30	28,40	31,60	33,50	32,80	32,00	28,70	26,90	28,50	29,60	26,50	22,15
	-	-	I	-	-	-	-	-	-	-	-	-	-	-	-
	11,3975	39,33		—26,00	—23,78	—15,22	— 9,33	— 3,28	5,89	13,33	11,11	2,00	— 5,39	—15,11	—23,67
	11,4000	36,427	VI	—25,194	—21,799	—16,873	— 7,614	+ 1,442	7,745	11,233	9,857	4,129	— 4,183	—13,503	—21,594
	12,5290	44,28		—28,50	—23,17	—14,67	—10,67	— 2,06	7,67	15,78	11,78	3,67	— 7,72	—19,33	—24,78
	12,5300	40,038	VI	—29,449	—25,718	—20,304	—10,127	— 0,173	6,755	10,588	9,076	2,781	— 6,355	—16,599	—25,492
	9,4758	31,66		—15,22	—12,78	— 6,67	+ 0,28	6,61	13,33	16,44	13,83	7,78	0,56	— 6,94	—13,83
	9,4800	30,292	V	—16,251	—13,428	— 9,332	— 1,632	5,899	11,140	14,041	12,897	8,134	1,222	— 6,529	—13,257
	11,6808	38,72		—18,83	—15,83	— 7,61	+ 0,44	10,39	16,28	19,89	17,50	9,17	1,11	— 7,89	—16,11
	11,6800	37,322	VI	—20,432	—16,955	—11,907	— 2,420	6,858	13,316	16,890	15,480	9,612	1,096	— 8,453	—16,743
	10,3808	35,00		—16,50	—15,67	— 6,61	+ 0,50	9,56	15,56	18,50	15,06	7,89	1,94	— 5,39	—12,39
	10,3800	33,168	V	—16,547	—13,456	— 8,970	— 0,540	7,606	13,445	16,621	15,368	10,153	2,585	— 5,901	—13,268
	10,9467	35,88		—17,88	—15,62	—10,12	— 2,12	6,62	14,12	18,00	15,38	8,38	0,62	— 7,50	—15,00
	12,2772	38,25		—19,75	—15,31	—11,00	— 1,12	8,12	15,25	18,50	14,88	7,88	0,62	—14,12	—18,38
	12,1658	39,44		—19,72	—18,06	— 8,83	— 1,17	8,72	15,44	19,72	15,78	9,22	0,61	—10,33	—18,39
	11,7800	37,641	VI	—20,558	—17,050	—11,960	— 2,392	6,966	13,479	17,083	15,661	9,743	1,154	— 8,477	—16,838
	12,4258	39,94		—19,50	—17,78	— 9,00	0,00	10,39	16,44	20,44	16,89	10,50	0,89	— 9,11	—18,17
	12,4300	39,718	VI	—19,768	—16,066	—10,695	— 0,599	9,275	16,147	19,951	18,450	12,205	3,143	— 7,020	—15,842
	12,4362	39,63		—20,88	—15,38	—12,62	+ 0,75	10,38	16,50	18,75	15,75	8,62	0,88	—10,25	—17,62
	12,2492	38,61		—18,28	—17,00	— 8,78	+ 0,78	11,72	17,28	20,33	16,94	10,67	1,94	— 8,50	—16,33
	12,3000	39,303	VI	—19,153	—15,490	—10,175	— 0,184	9,586	16,387	20,150	18,666	12,486	3,518	— 6,538	—15,268
	11,5767	36,88		—17,34	—12,30	— 5,99	6,34	12,49	17,65	19,54	16,12	7,51	1,08	— 8,25	—16,47
	11,8912	37,50		—15,50	—15,94	— 8,00	5,56	14,78	19,67	21,56	19,50	12,33	4,11	— 3,22	—10,00
	11,7900	37,673	VI	—15,026	—11,515	— 6,421	3,156	12,521	19,040	22,647	21,224	15,301	6,705	— 2,935	—11,302
	12,5491	39,61		—18,61	—16,50	— 9,72	1,67	13,50	18,33	21,00	18,33	10,89	1,94	— 8,17	—14,89
	12,5500	40,102	VI	—18,437	—14,699	— 9,276	0,917	10,887	17,825	21,665	20,150	13,845	4,695	— 5,566	—14,473
	13,0499	41,22		—18,00	—16,22	— 7,72	2,94	14,89	20,28	23,22	20,22	13,00	3,39	— 7,22	—15,11
	13,0500	41,699	VI	—18,346	—14,460	— 8,820	1,779	12,146	19,361	23,353	21,779	15,222	5,707	— 4,962	—14,224

No.	Section	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		Mean yearly temperat., $= M$	Calcut. yearly temp. composed of			$\Sigma (+ Q'm)$
							years	number of years		temp. at sea-level: normal temperat. at lat. $\varphi = T\varphi$	temp. at sea-level: thermo-geographical component $= t\varphi,\lambda$	correction for Height, 0,50 °C per 100 m.	
	1	2	3	4	5	6	7	8	9	10	11	12	13
50	IV	Irgis	48° 37′	61° 16′	112	Chall. Rep.	1870—84	15	+ 5,2417				4,0400
			48° 37′	61° 16′	112	Formulæ	normal	-	+ 5,8310	+ 7,3769	−0,9859	−0,5600	3,8874
51	IV	Petro-	41° 28′	61° 5′	100	Chall. Rep.	1870—84	15	+12,6283				4,0651
		Alexandrowsk	41° 28′	61° 5′	100	Formulæ	normal	-	+13,6644	+12,4992	+1,6652	−0,5000	3,8874
52	IV	Taschkent	41° 19′	69° 16′	462	Chall. Rep.	1870—84	15	+13,5425				3,6328
			41° 19′	69° 16′	462	Formulæ	normal	-	+12,1828	+12,6025	+1,8903	−2,3100	3,8874
53	IV	Samarkand	39° 39′	66° 57′	725	Chall. Rep.	1870—84	15	+14,1117				3,5802
			39° 39′	66° 57′	725	Formulæ	normal	-	+12,4898	+13,7376	+2,3772	−3,6250	3,8874
54	IV	Moolton	30° 10′	71° 33′	128	Chall. Rep.	1870—84	15	+24,4733				4,8034
			30° 10′	71° 33′	128	Formulæ	normal	-	+22,6929	+19,6244	+3,7085	−0,6400	3,8874
55	IV	Delhi	28° 40′	77° 16′	219	Chall. Rep.	1870—84	15	+25,1017				-
			28° 40′	77° 16′	219	Formulæ	normal	-	+22,6989	+20,4502	+3,3437	−1,0950	-
56	IV	Benares	25° 18′	82° 56′	94	Dove	bef. 1848	$2^3/_4$	+26,8150				-
			25° 20′	83° 2′	81	Chall. Rep.	1870—84	15	+25,4542				-
			25° 20′	83° 2′	81	Formulæ	normal	-	+24,2877	+22,1656	+2,5271	−0,4050	-
57	IV	Calcutta	22° 38′	88° 20′	24	Dove	bef. 1848	4	+28,0017				-
			22° 32′	88° 20′	7	Chall. Rep.	1870—84	15	+25,7492				-
			22° 32′	88° 20′	7	Formulæ	normal	-	+25,9722	+23,4703	+2,5369	−0,0350	-
58	IV	Bombay	18° 56′	72° 54′	-	Dove	bef. 1848	$1^1/_3$	+27,3633				-
			18° 54′	72° 49′	11	Chall. Rep.	1870—84	15	+26,3133				-
			18° 54′	72° 49′	11	Formulæ	normal	-	+27,9242	+24,9642	+3,0150	−0,0550	-
59	V	Jan Mayen	70° 59′	8° 28′	10	Chall. Rep.	1882—83	1	— 2,3058				4,2103
			70° 59′	8° 28′	10	Formulæ	normal	-	— 0,1880	— 9,4360	+9,2980	−0,0500	3,8874
60	V	Stykkisholm	65° 5′	22° 46′	11	Chall. Rep.	1870—84	15	+ 2,8525				3,5677
			65° 5′	22° 46′	11	Met. Inst., Cophg.	1846—83	38	+ 2,8417				3,5586
			65° 5′	22° 46′	11	Formulæ	normal	-	+ 2,8212	— 5,0755	+7,9517	−0,0550	3,8874
61	V	Thorshavn	62° 2′	6° 46′	-	Dove	bef. 1848	3	+ 7,5608				3,2402
			62° 2′	6° 43′	4	Chall. Rep.	1870—84	15	+ 6,4392				3,5248
			62° 2′	6° 43′	4	Formulæ	normal	-	+ 6,5615	— 2,7713	+9,3328	-	3,8874
62	V	Ivigtut	61° 12′	48° 11′	5	Chall. Rep.	1874—84	11	+ 0,8375				3,6609
			61° 12′	48° 11′	5	Met. Inst., Cophg.	1875—88	9	+ 1,0083				3,6374
			61° 12′	48° 11′	5	Formulæ	normal	-	+ 0,7532	— 2,1382	+2,8914	-	3,8874
63	V	Stornoway	58° 13′	6° 23′	21	Chall. Rep.	1870—84	15	+ 7,7467				3,5155
			58° 13′	6° 23′	21	Formulæ	normal	-	+ 8,6383	+ 0,1343	+8,6090	−0,1050	3,8874

	MV	Amplitude	Class of climate	Jan. °C	Feb. °C	March °C	April °C	May °C	June °C	July °C	August °C	Septb. °C	Octb. °C	Novbr. °C	Decbr. °C
	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
	13,2297	41,39		—16,50	—16,06	— 6,28	6,78	18,06	22,78	24,89	23,00	15,17	5,39	— 3,33	—11,00
	13,2300	42,666	VI	—16,226	—12,249	— 6,479	4,366	14,972	22,355	26,440	24,829	18,120	8,385	— 2,532	—12,008
	10,6383	33,22		— 4,89	— 3,11	6,94	15,44	23,11	26,39	28,33	26,89	19,44	10,89	3,44	— 1,33
	10,6400	33,999	V	— 3,912	— 0,743	3,855	12,497	20,949	26,831	30,087	28,803	23,457	15,700	7,001	— 0,551
	8,4875	28,89		— 1,33	0,39	8,89	15,28	22,39	25,72	27,56	25,00	17,56	11,61	6,44	3,00
	8,4900	27,128	IV	— 1,842	0,687	4,355	11,251	17,995	22,689	25,287	24,262	19,997	13,807	6,866	0,840
	8,1200	28,39		— 0,67	1,39	9,00	14,44	21,67	25,56	27,72	25,11	18,89	13,50	8,17	4,56
	8,1200	25,946	IV	— 0,923	1,495	5,004	11,599	18,049	22,538	25,023	24,043	19,963	14,043	7,404	1,641
	6,8745	22,11		12,56	14,78	21,33	26,61	31,50	34,67	33,06	31,50	30,22	25,00	18,89	13,56
	6,8700	21,952	IV	11,345	13,390	16,359	21,939	27,396	31,195	33,297	32,467	29,016	24,007	18,390	13,514
	5,8163	19,56		14,61	16,94	23,56	29,22	32,06	34,17	30,44	30,06	28,94	25,72	19,89	15,61
	-	-	III	-	-	-	-	-	-	-	-	-	-	-	-
	4,7792	17,66		16,98	22,50	26,15	32,17	34,64	32,38	29,84	29,85	30,00	27,50	22,30	17,47
	5,1370	16,94		16,11	19,00	25,17	30,56	32,94	32,94	29,44	29,06	28,50	25,56	20,17	16,00
	-	-	III	-	-	-	-	-	-	-	-	-	-	-	-
	3,1611	11,73		20,71	23,95	28,61	31,61	32,44	31,47	29,94	29,77	30,03	29,11	25,96	22,42
	3,1578	10,00		19,22	22,22	26,44	29,00	29,22	29,00	28,22	28,06	28,11	26,89	23,22	19,39
	-	-	II	-	-	-	-	-	-	-	-	-	-	-	-
	1,2445	5,31		24,60	25,59	26,47	29,00	29,91	29,64	27,80	27,27	27,31	28,08	27,16	25,53
	1,3278	5,84		23,22	23,94	26,11	27,83	29,06	28,33	27,00	26,61	26,44	26,89	25,89	24,44
	-	-	I	-	-	-	-	-	-	-	-	-	-	-	-
	4,0741	13,78		— 7,28	— 4,39	—10,28	— 2,72	— 4,00	1,89	3,50	3,11	1,89	2,11	— 1,89	— 9,61
	4,1000	13,101	III	— 6,961	— 5,740	— 3,968	— 0,638	+ 2,619	4,886	6,140	5,645	3,584	0,596	— 2,756	— 5,666
	4,0542	12,00		— 2,33	— 2,22	— 2,44	0,78	4,33	7,89	9,67	9,33	6,89	3,33	0,56	— 1,56
	4,0083	12,30		— 2,2	— 2,7	— 2,3	0,7	4,4	7,8	9,6	9,2	6,9	3,2	0,6	— 1,1
	4,0000	12,781	III	— 3,786	— 2,595	— 0,867	2,382	5,560	7,771	8,995	8,512	6,503	3,586	0,316	— 2,523
	3,0777	10,50		3,06	2,73	4,26	5,45	7,43	11,91	13,26	12,53	10,82	7,75	5,39	6,14
	2,6441	7,67		3,33	3,50	3,39	5,22	7,06	9,50	10,94	11,00	9,22	6,78	4,22	3,11
	2,6400	8,426	I	2,211	2,987	4,128	6,272	8,369	9,819	10,636	10,318	8,991	7,066	4,908	3,034
	5,4196	17,33		— 7,61	— 8,11	— 5,00	0,89	4,78	8,22	9,72	8,33	5,22	1,22	— 2,61	— 5,00
	5,2084	16,60		— 7,0	— 7,0	— 4,9	0,9	4,6	8,3	9,6	8,2	5,3	1,3	— 2,2	— 5,0
	5,3100	16,967	III	— 8,018	— 6,437	— 4,142	0,170	4,389	7,324	8,949	8,308	5,640	1,769	— 2,572	— 6,341
	3,0133	9,17		3,78	4,28	4,67	6,67	8,67	11,33	12,89	12,89	10,89	7,89	5,28	3,72
	3,0100	9,618	II	3,666	4,563	5,863	8,308	10,699	12,363	13,284	12,921	11,409	9,214	6,753	4,617

No.	Section	PLACE	Latitude = φ	Longitude = λ	Height, metres	AUTHORITY	PERIOD		Mean yearly temperat., = M	Calcut. yearly temp. composed of			$\Sigma\,(+\,Q'm)$
							years	number of years		temp. at sea-level		correction for Height, 0,50 °C per 100 m.	
										normal temperat. at lat. φ = $T\varphi$	thermo-geographical component = $t\varphi,\lambda$		
	1	2	3	4	5	6	7	8	9	10	11	12	13
64	V	North Atlantic	57° 30′	47° 30′	-	Chall. Rep.	-	$5^2/_3$	+ 1,9625				3,8384
			57° 30′	47° 30′	-	Formulæ	normal	-	3,0979	+ 0,6807	+2,4172	-	3,8874
65	V	North Atlantic	57° 30′	12° 30′	-	Chall. Rep.	-	$5^2/_3$	9,0325				3,6608
			57° 30′	12° 30′	-	Formulæ	normal	-	9,0032	+ 0,6807	+8,3225	-	3,8874
66	V	Glasgow	55° 53′	4° 18′	56	Chall. Rep.	1870—84	15	8,2583				3,5341
			55° 53′	4° 18′	56	Formulæ	normal	-	9,5018	+ 1,9121	+7,8697	—0,2800	3,8874
67	V	North Atlantic	52° 30′	47° 30′	-	Chall. Rep.	-	$5^2/_3$	4,3283				4,1849
			52° 30′	47° 30′	-	Formulæ	normal	-	5,3612	+ 4,4765	+0,8847	-	3,8874
68	V	North Atlantic	52° 30′	12° 30′	-	Chall. Rep.	-	$5^2/_3$	11,7142				3,9717
			52° 30′	12° 30′	-	Formulæ	normal	-	11,4886	+ 4,4765	+7,0121	-	3,8874
69	V	Valentia	51° 55′	10° 18′	7	Chall. Rep.	1870—84	15	10,6942				3,8165
			51° 55′	10° 18′	7	Formulæ	normal	-	11,6694	+ 4,9167	+6,7887	—0,0350	3,8874
70	V	Oxford	51° 46′	1° 16′	-	Dove	bef. 1848	2	9,4400				3,9505
			51° 46′	1° 16′	65	Chall. Rep.	1870—84	15	9,7775				3,4985
			51° 46′	1° 16′	65	Formulæ	normal	-	10,5438	+ 5,0285	+5,8403	—0,3250	3,8874
71	V	Pembroke	51° 41′	5° 30′	46	Chall. Rep.	1870—84	15	10,1375				3,6793
			51° 41′	5° 30′	46	Formulæ	normal	-	11,2326	+ 5,0912	+6,3714	—0,2300	3,8874
72	V	Isle of Wight (Osborne)	50° 45′	1° 20′	-	Dove	bef. 1848	10	10,2300				3,5290
			50° 45′	1° 16′	53	Chall. Rep.	1870—84	15	10,3333				3,8288
			50° 45′	1° 16′	53	Formulæ	normal	-	10,8517	+ 5,7909	+5,3258	—0,2650	3,8874
73	VI	Brest	48° 23′	4° 30′	63	Chall. Rep.	1870—84	15	11,7125				3,6690
			48° 23′	4° 30′	63	Formulæ	normal	-	12,3024	+ 7,5491	+5,0683	—0,3150	3,8874
74	VI	North Atlantic	47° 30′	47° 30′	-	Chall. Rep.	-	$5^2/_3$	7,1058				3,9439
			47° 30′	47° 30′	-	Formulæ	normal	-	9,1874	+ 8,1985	+0,9889	-	3,8874
75	VI	North Atlantic	47° 30′	12° 30′	-	Chall. Rep.	-	$5^2/_3$	14,0067				3,6113
			47° 30′	12° 30′	-	Formulæ	normal	-	13,3511	+ 8,1985	+5,1526	-	3,8874
76	VI	North Atlantic	42° 30′	47° 30′	-	Chall. Rep.	-	$5^2/_3$	12,9017				3,9261
			42° 30′	47° 30′	-	Formulæ	normal	-	13,8721	+11,7818	+2,0903	-	3,8874
77	VI	North Atlantic	42° 30′	12° 30′	-	Chall. Rep.	-	$5^2/_3$	16,3067				3,4526
			42° 30′	12° 30′	-	Formulæ	normal	-	14,4849	+11,7818	+2,7031	-	3,8874
78	VI	Madrid	40° 24′	3° 42′	655	Chall. Rep.	1870—84	15	13,6158				3,2628
			40° 24′	3° 42′	655	Formulæ	normal	-	11,6800	+13,2300	+1,7250	—3,2750	3,8874

	MV	Amplitude	Class of climate	Jan. °C	Feb. °C	March °C	April °C	May °C	June °C	July °C	August °C	Septb. °C	Octb. °C	Novbr. °C	Decbr. °C
14	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
	4,5725	14,28		— 5,17	— 5,11	— 2,94	1,11	4,00	7,22	9,11	8,72	6,83	3,33	— 0,72	— 2,83
	4,5700	14,603	III	— 4,451	— 3,090	— 1,115	2,596	6,227	8,753	10,152	9,600	7,304	3,972	+ 0,236	— 3,008
	2,6892	7,83		5,61	5,61	6,17	7,94	9,67	12,17	13,44	13,33	12,28	9,44	7,06	5,67
	2,6900	8,595	I	4,560	5,361	6,523	8,708	10,845	12,332	13,155	12,831	11,479	9,518	7,319	5,409
	3,6767	11,28		3,33	4,11	4,72	7,17	9,72	12,94	14,50	14,28	11,89	8,28	4,94	3,22
	3,6800	11,759	II	3,423	4,519	6,109	9,098	12,021	14,056	15,182	14,738	12,889	10,206	7,197	4,585
	4,4583	14,55		— 2,61	— 3,11	— 1,00	3,28	5,72	8,94	10,72	11,44	9,72	6,17	2,67	0,00
	4,4600	14,251	III	— 2,006	— 0,678	+ 1,249	4,872	8,415	10,881	12,245	11,707	9,466	6,214	2,568	— 0,598
	2,5458	7,95		7,94	8,67	9,06	10,50	12,33	14,56	15,56	15,89	14,61	12,61	10,28	8,56
	2,5500	8,148	I	7,276	8,036	9,138	11,209	13,234	14,644	15,424	15,117	13,836	11,976	9,892	8,082
	2,6308	7,89		7,39	7,50	7,94	9,44	11,56	13,50	14,83	15,28	13,67	11,11	8,67	7,44
	2,6300	8,404	I	7,325	8,108	9,245	11,381	13,470	14,924	15,729	15,411	14,090	12,172	10,022	8,156
	4,2600	13,91		2,05	4,64	6,26	7,80	12,98	14,77	15,91	15,96	12,80	9,78	7,51	2,82
	4,1475	13,00		3,89	4,89	6,11	8,83	11,44	15,00	16,89	16,61	13,78	9,83	6,17	3,89
	4,1600	13,293	III	3,672	4,911	6,709	10,087	13,392	15,692	16,965	16,463	14,373	11,340	7,938	4,986
	3,1842	9,55		6,17	6,06	6,33	8,44	10,61	13,61	15,33	15,61	13,83	10,94	8,33	6,39
	3,1800	10,161	II	5,988	6,927	8,301	10,884	13,410	15,168	16,141	15,757	14,159	11,841	9,241	6,984
	4,7700	15,56		2,78	5,00	6,66	7,77	13,34	16,66	18,34	16,66	14,45	10,55	6,66	3,89
	4,4070	13,39		4,33	4,22	6,56	9,17	12,06	15,44	17,50	17,61	15,00	10,83	6,89	4,39
	4,6500	14,858	III	3,171	4,555	6,565	10,341	14,035	16,606	18,029	17,468	15,131	11,741	7,939	4,639
	3,7408	11,72		6,39	7,28	8,11	10,61	13,00	15,28	17,83	18,11	16,11	12,39	9,00	6,44
	3,7400	11,951	II	6,124	7,238	8,854	11,892	14,863	16,931	18,075	17,624	15,745	13,018	9,960	7,306
	4,3475	14,61		0,61	— 0,11	2,39	5,44	7,67	10,94	13,72	14,50	12,72	9,17	5,50	2,72
	4,3500	13,900	III	2,002	+ 3,297	5,177	8,710	12,166	14,571	15,902	15,377	13,191	10,019	6,463	3,376
	2,4033	7,95		10,72	10,89	11,56	12,28	14,06	16,28	18,00	18,67	16,78	14,67	12,89	11,28
	2,4000	7,669	I	9,387	10,101	11,138	13,088	14,994	16,321	17,055	16,766	15,560	13,810	11,848	10,145
	4,1735	14,05		7,44	5,78	8,11	9,78	12,33	16,44	19,28	19,83	18,61	15,39	12,11	9,72
	4,1700	13,325	III	6,984	8,226	10,028	13,414	16,727	19,033	20,308	19,805	17,710	14,670	11,261	8,301
	2,8617	9,56		12,11	12,72	13,78	14,17	16,50	18,78	21,28	21,67	19,67	17,11	15,28	12,61
	2,8600	9,139	I	9,761	10,612	11,848	14,171	16,443	18,024	18,899	18,554	17,117	15,032	12,694	10,664
	6,3102	21,16		4,50	6,50	9,00	11,83	15,83	20,50	25,22	24,89	19,50	13,28	8,28	4,06
	6,3100	20,163	IV	1,257	3,136	5,862	10,987	16,000	19,489	21,419	20,658	17,488	12,887	7,728	3,250

No.	Section	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		Mean yearly temperat., $= M$	Calcul. yearly temp. composed of			$\Sigma (m Q +)$
							years	number of years		temp. at sea-level: normal temperat. at lat. $\varphi = T\varphi$	temp. at sea-level: thermo-geographical component $= t\varphi,\lambda$	correction for Height, 0,50 °C per 100 m.	
	1	2	3	4	5	6	7	8	9	10	11	12	13
79	VI	Lisbon	38° 42′	9° 9′	-	Dove	bef. 1848	5	+16,3333				3,7372
			38° 42′	9° 8′	102	Chall. Rep.	1870—84	15	15,4867				3,6600
			38° 42′	9° 8′	102	Formulæ	normal	-	15,3407	+14,3729	+1,4778	−0,5100	3,8874
80	VI	St. Michael	37° 45′	25° 15′	-	Dove	bef. 1848	1	16,8978				4,3758
			37° 45′	25° 15′	-	Formulæ	normal	-	16,3013	+14,9991	+1,3022	-	3,8874
81	VI	North Atlantic	37° 30′	47° 30′	-	Chall. Rep.	-	$5^2/_3$	18,0275				4,3098
			37° 30′	47° 30′	-	Formulæ	normal	-	17,4023	+15,1624	+2,2399	-	3,8874
82	VI	North Atlantic	37° 30′	12° 30′	-	Chall. Rep.	-	$5^2/_3$	17,8817				3,8596
			37° 30′	12° 30′	-	Formulæ	normal	-	16,3472	+15,1624	+1,1848	-	3,8874
83	VI	Gibraltar	36° 7′	5° 21′	-	Dove	bef. 1848	2	19,6907				3,3007
			36° 8′	5° 20′	16	Chall. Rep.	1870—84	15	18,5142				3,6611
			36° 8′	5° 20′	16	Formulæ	normal	-	17,3292	+16,0427	+1,3665	−0,0800	3,8874
84	VI	Funchal	32° 38′	16° 56′	25	Dove	bef. 1848	1	19,7833				4,4534
			32° 38′	16° 56′	25	Formulæ	normal	-	18,0852	+18,1987	+0,0115	−0,1250	3,8874
85	VI	North Atlantic	32° 30′	47° 30′	-	Chall. Rep.	-	$5^2/_3$	21,3050				4,3081
			32° 30′	47° 30′	-	Formulæ	normal	-	19,8898	+18,2778	+1,6120	-	3,8874
86	VI	North Atlantic	32° 30′	12° 30′	-	Chall. Rep.	-	$5^2/_3$	20,0142				4,4667
			32° 30′	12° 30′	-	Formulæ	normal	-	18,7108	+18,2778	+0,4330	-	3,8874
87	VI	North Atlantic	27° 30′	47° 30′	-	Chall. Rep.	-	$5^2/_3$	23,2867				-
			27° 30′	47° 30′	-	Formulæ	normal	-	21,5082	+21,0698	+0,4384	-	-
88	VI	North Atlantic	27° 30′	22° 30′	-	Chall. Rep.	-	$5^2/_3$	21,8650				-
			27° 30′	22° 30′	-	Formulæ	normal	-	19,6169	+21,0698	−1,4529	-	-
89	VI	Las Palmas	27° 28′	17° 48′	9	Chall. Rep.	1880—84	5	20,8608				-
			27° 28′	17° 48′	9	Formulæ	normal	-	+20,1769	+21,0872	−0,8653	−0,0450	-
90	VII	Upernivik	72° 47′	55° 53′	12	Chall. Rep.	1870—84	11	− 8,0883				4,0662
			72° 48′	55° 54′	12	Met. Inst., Coph.	1875—83	9	− 8,2000				4,0462
			72° 48′	55° 54′	12	Formulæ	normal	-	−10,1245	−10,7421	+0,6776	−0,0600	3,8874
91	VII	Jacobshavn	69° 13′	50° 55′	13	Chall. Rep.	1870—84	11	− 4,9083				3,6806
			69° 13′	51° 2′	13	Met. Inst., Coph.	1866—83	18	− 5,1833				3,6477
			69° 13′	51° 2′	13	Formulæ	normal	-	− 5,9221	− 8,1475	+2,2904	−0,0650	3,8874
92	VII	Godthaab	64° 10′	52° 24′	-	Dove	bef. 1848	$13^1/_2$	− 2,9033				3,8731
			64° 11′	51° 45′	11	Chall. Rep.	1870—84	11	− 1,8150				3,6195
			64° 10′	51° 44′	11	Met. Inst., Coph.	1866—83	18	− 1,8833				3,6233
			64° 10′	51° 44′	11	Formulæ	normal	-	− 2,4925	− 4,3856	+1,9481	−0,0550	3,8874

	MV	Amplitude	Class of climate	Jan. °C	Feb. °C	March °C	April °C	May °C	June °C	July °C	August °C	Septb. °C	Octb. °C	Novbr. °C	Decbr. °C
	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
	3,7167	11,50		11,40	12,00	13,50	15,00	17,60	20,80	22,30	21,80	20,80	17,00	13,00	10,80
	3,4300	11,22		10,44	11,28	12,39	14,28	16,39	17,94	21,11	21,50	19,89	16,67	13,67	10,28
	3,5000	11,184	II	9,559	10,601	12,114	14,957	17,737	19,672	20,743	20,320	18,562	16,010	13,149	10,665
	2,2625	7,988		15,000	15,000	15,275	16,100	17,212	19,438	20,000	21,100	20,000	17,212	13,325	13,112
	2,2600	7,221	I	12,568	13,241	14,218	16,053	17,849	19,098	19,790	19,517	18,381	16,734	14,886	13,282
	3,2920	11,17		13,78	13,11	13,89	15,22	17,44	20,56	22,61	24,28	22,22	20,22	17,50	15,50
	3,2900	10,513	II	11,968	12,947	14,369	17,041	19,655	21,474	22,480	22,083	20,430	18,032	15,342	13,007
	2,7583	9,17		14,00	14,28	15,17	16,17	18,00	20,00	22,17	23,17	21,33	19,17	17,06	14,06
	2,7600	8,819	I	11,788	12,610	13,803	16,044	18,237	19,763	20,607	20,274	18,887	16,875	14,619	12,660
	3,6700	12,124		14,450	14,238	17,338	18,888	20,862	23,962	26,362	26,050	23,238	19,650	16,712	14,538
	3,6892	12,11		13,61	14,00	14,67	17,22	18,94	22,11	24,56	25,28	22,89	19,44	16,28	13,17
	3,6900	11,791	II	11,234	12,333	13,927	16,924	19,855	21,896	23,025	22,579	20,725	18,035	15,018	12,399
	2,0167	6,00		17,50	17,30	17,90	18,00	18,20	20,40	22,50	23,10	23,30	21,70	19,80	17,70
	2,0000	6,391	I	14,781	15,377	16,241	17,866	19,454	20,560	21,172	20,931	19,926	18,468	16,833	15,413
	2,6100	9,11		18,17	17,33	17,61	18,67	20,67	22,78	24,94	26,44	25,06	22,83	21,44	19,72
	2,6100	8,340	I	15,578	16,356	17,484	19,603	21,677	23,120	23,918	23,603	22,292	20,389	18,255	16,403
	2,3048	7,39		17,11	16,89	17,22	18,11	19,83	21,44	23,11	24,28	23,29	21,78	20,00	17,11
	2,3000	7,349	I	14,912	15,596	16,590	18,458	20,285	21,557	22,261	21,983	20,828	19,151	17,270	15,638
	1,9744	6,78		20,83	20,39	20,44	21,50	22,72	24,11	26,11	27,17	26,22	24,67	23,22	22,06
	-	-	I	-	-	-	-	-	-	-	-	-	-	-	-
	1,9317	5,83		19,44	19,00	19,33	20,33	21,00	22,67	24,28	24,78	24,83	23,72	22,50	20,50
	-	-	I	-	-	-	-	-	-	-	-	-	-	-	-
	1,9159	5,39		18,50	18,33	18,50	19,06	20,78	21,94	22,78	23,67	23,11	23,72	21,44	18,50
	-	-	I	-	-	-	-	-	-	-	-	-	-	-	-
	8,6800	28,22		—21,00	—23,50	—21,00	—12,22	— 3,78	1,61	4,72	4,11	1,11	— 4,22	— 8,28	—14,61
	8,7667	28,3		—21,1	—23,5	—21,1	—13,1	— 3,7	1,6	4,8	4,0	0,9	— 4,2	— 8,3	—14,7
	8,7200	27,863	IV	—24,529	—21,932	—18,164	—11,082	— 4,155	0,667	3,335	2,282	— 2,099	— 8,457	—15,586	—21,775
	7,6116	25,28		—15,78	—17,78	—15,67	— 7,39	— 0,22	4,72	7,50	6,11	1,89	— 3,78	— 7,39	—11,11
	7,6500	25,1		—16,0	—17,7	—16,4	— 8,3	— 0,1	4,3	7,4	5,9	1,5	— 4,2	— 7,4	—11,2
	7,6300	24,380	IV	—18,526	—16,254	—12,957	— 6,760	— 0,699	3,520	5,855	4,934	1,100	— 4,463	—10,701	—16,116
	5,4320	16,412		—10,900	—10,800	— 9,112	— 5,550	0,088	3,838	5,512	4,912	2,022	— 1,200	— 5,588	— 8,062
	5,1850	16,78		— 9,72	—10,00	— 8,28	— 3,00	1,00	4,61	6,78	6,11	3,11	— 1,39	— 3,78	— 7,22
	5,1833	16,8		— 9,8	—10,1	— 8,3	— 3,3	1,4	4,4	6,7	6,0	2,8	— 1,5	— 3,6	— 7,3
	5,2700	16,840	III	—11,198	— 9,629	— 7,351	— 3,071	1,115	4,029	5,642	5,006	2,358	— 1,485	— 5,793	— 9,533

No.	Section	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		Mean yearly temperat., $= M$	Calcul. yearly temp. composed of			$M + Q'm$
							years	number of years		temp. at sea-level: normal temperat. at lat. $\varphi = T\varphi$	temp. at sea-level: thermo-geographical component $= t\varphi,\lambda$	correction for Height, 0,50 °C per 100 m.	
	1	2	3	4	5	6	7	8	9	10	11	12	13
93	VII	Nain	57° 10′	61° 50′	-	Dove	bef. 1848	6	— 2,3473				4,1950
			56° 33′	61° 41′	4	Chall. Rep.	1882—85	3 1/3	— 5,7258				4,2220
			56° 33′	61° 41′	4	Deutsche Seew.	1884—87	4	— 5,4328				4,3103
			56° 33′	61° 41′	4	Formulæ	normal	-	— 1,9737	+ 1,4046	—3,3583	—0,0200	3,8874
94	VII	Belle-Isle	51° 53′	55° 22′	122	Chall. Rep.	1882—84	2 1/3	— 0,7408				3,6084
			51° 53′	55° 22′	122	Formulæ	normal	-	+ 1,9651	+ 4,9408	—2,3657	—0,6100	3,8874
95	VII	Moose-Factory	51° 15′	80° 45′	10	Chall. Rep.	1857—80	24	— 1,5525				4,0026
			51° 15′	80° 45′	10	Formulæ	normal	-	— 0,8818	+ 5,4164	—6,2482	—0,0500	3,8874
96	VIII	St. Johns N. F.	47° 34′	52° 42′	46	Chall. Rep.	1870—84	15	+ 4,9808				3,8117
			47° 34′	52° 42′	46	Formulæ	normal	-	6,8809	+ 8,1496	—1,0387	—0,2300	3,8874
97	VIII	Quebec	46° 48′	71° 17′	-	Dove	bef. 1848	-	5,4698				3,5862
			40° 48′	71° 12′	95	Chall. Rep.	1870—84	15	3,7458				3,9676
			46° 48′	71° 12′	95	Formulæ	normal	-	3,9714	+ 8,7100	—4,2636	—0,4750	3,8874
98	VIII	North Atlantic	42° 30′	67° 30′	-	Chall. Rep.	-	5 2/3	8,4444				4,0970
			42° 30′	67° 30′	-	Formulæ	normal	-	9,5028	+11,7818	—2,2790	-	3,8874
99	VIII	Chicago	41° 52′	87° 38′	201	Chall. Rep.	1870—84	15	9,6475				3,9055
			41° 52′	87° 38′	201	Formulæ	normal	-	8,5147	+12,2225	—2,7028	—1,0050	3,8874
100	VIII	New York	40° 43′	74° 1′	-	Dove	bef. 1848	1	10,8541				3,9116
			40° 43′	74° 0′	50	Chall. Rep.	1870—84	15	10,7778				3,9144
			40° 43′	74° 0′	50	Formulæ	normal	-	10,3827	+13,0141	—2,3814	—0,2500	3,8874
101	VIII	St. Louis	38° 36′	89° 36′	-	Dove	bef. 1848	7	12,8605				3,7590
			38° 27′	90° 12′	174	Chall. Rep.	1870—84	15	13,0883				3,9421
			38° 27′	90° 12′	174	Formulæ	normal	-	11,9287	+14,5386	—1,7399	—0,8700	3,8874
102	VIII	North Atlantic	37° 30′	72° 30′	-	Chall. Rep.	-	5 2/3	14,4300				3,9293
			37° 30′	72° 30′	-	Formulæ	normal	-	13,8395	+15,1624	—1,3229	-	3,8874
103	VIII	Cairo	37° 0′	89° 10′	115	Chall. Rep.	1870—84	15	14,3517				3,8505
			37° 0′	89° 10′	115	Formulæ	normal	-	13,1525	+15,4868	—1,7593	—0,5750	3,8874
104	VIII	Cape Hatteras	35′ 14°	75° 30′	2	Chall. Rep.	1870—84	15	16,2108				3,7606
			35° 14′	75° 30′	2	Formulæ	normal	-	15,6521	+16,6112	—0,9591	-	3,8874
105	VIII	Charleston	32° 49′	79° 56′	15	Chall. Rep.	1870—84	15	19,0592				3,7513
			32° 49′	79° 56′	15	Formulæ	normal	-	17,3392	+18,0895	—0,6753	—0,0750	3,8874
106	VIII	North Atlantic	32° 30′	77° 30′	-	Chall. Rep.	-	5 2/3	18,2778				3,9246
			32° 30′	77° 30′	-	Formulæ	normal	-	17,8282	+18,2775	—0,4493	-	3,8874

	MV	Amplitude	Class of climate	Jan. °C	Feb. °C	March °C	April °C	May °C	June °C	July °C	August °C	Septb. °C	Octb. °C	Novbr. °C	Decbr. °C
	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
	8,7458	27,275		−16,500	−15,888	−13,906	− 1,762	2,800	6,100	10,162	10,775	7,150	+ 0,819	− 4,106	−13,812
	10,2075	32,78		−24,00	−22,11	−17,78	− 6,33	0,22	5,72	8,78	8,28	4,89	− 1,00	− 7,44	−17,94
	9,9445	33,485		−24,515	−21,442	−15,750	− 6,135	0,358	5,615	8,410	8,970	4,552	− 0,835	− 6,870	−17,552
	9,6300	30,771	V	−17,881	−15,015	−10,852	− 3,031	4,619	9,944	12,890	11,728	6,889	− 0,132	− 8,005	−14,840
	7,2875	26,72		−14,22	− 7,89	− 9,06	− 2,22	1,17	4,72	11,39	12,50	7,44	2,06	− 3,39	−11,39
	7,2900	23,294	IV	−10,077	− 7,906	− 4,756	+ 1,165	6,956	10,987	13,217	12,337	8,675	3,359	− 2,601	− 7,775
	11,4492	37,89		−20,28	−18,78	−11,67	− 3,89	5,11	11,22	15,61	14,44	9,22	3,78	− 5,89	−17,50
	11,4500	36,587	VI	−19,796	−16,386	−11,438	− 2,139	6,957	13,288	16,791	15,409	9,656	1,308	− 8,053	−16,179
	6,2125	20,50		− 4,56	− 4,67	− 2,50	1,44	6,90	11,56	15,39	15,83	12,44	7,44	2,50	− 2,00
	6,2100	19,843	IV	− 3,377	− 1,528	+ 1,156	6,199	11,132	14,566	16,466	15,716	12,596	8,069	2,992	− 1,416
	10,4781	33,750		− 8,938	−10,750	− 5,188	4,262	12,688	17,750	23,000	19,375	16,875	6,000	+ 0,625	−10,063
	10,2130	31,89		−12,72	−10,28	− 5,78	1,83	9,72	16,56	19,17	18,17	13,50	6,50	− 2,00	− 9,72
	10,3000	32,912	V	−13,043	− 9,976	− 5,525	2,841	11,023	16,718	19,869	18,626	13,451	5,942	− 2,479	− 9,790
	6,2778	19,88		− 1,44	− 1,11	0,56	5,39	9,94	14,78	17,61	18,44	16,17	11,28	6,94	2,50
	6,2800	20,067	IV	− 0,871	+ 0,999	3,713	8,814	13,802	17,274	19,196	18,438	15,283	10,704	5,570	1,113
	8,5092	26,33		− 3,61	− 1,50	1,89	7,94	14,17	19,83	22,72	22,33	18,00	11,89	3,78	− 1,67
	8,5100	27,192	IV	− 5,543	− 3,009	0,669	7,581	14,341	19,046	21,650	20,623	16,347	10,143	3,185	− 2,855
	7,8369	27,125		− 4,250	− 0,250	4,875	11,625	16,875	19,875	22,875	22,125	18,000	11,625	5,625	1,250
	8,0463	24,05		− 0,94	− 0,17	2,56	8,44	15,11	20,50	23,11	22,39	18,67	13,17	6,00	0,67
	8,0500	25,723	IV	− 2,915	− 0,518	2,961	9,499	15,894	20,345	22,808	21,836	17,792	11,922	5,341	− 0,372
	7,9815	26,988		− 1,388	1,375	5,938	14,775	18,438	22,825	25,600	23,662	19,388	13,225	9,550	0,938
	8,3384	26,28		− 0,50	2,22	6,17	13,06	18,94	23,72	25,78	24,89	20,67	14,56	6,33	1,22
	8,2200	26,266	IV	− 1,650	0,798	4,350	11,027	17,556	22,101	24,616	23,624	19,494	13,501	6,781	0,947
	5,8283	17,33		6,00	6,33	7,39	11,22	16,00	20,28	23,33	23,06	21,44	17,44	12,11	8,56
	5,8300	18,629	III	4,209	5,945	8,465	13,200	17,831	21,054	22,838	22,134	19,205	14,955	10,188	6,050
	7,6163	24,89		1,33	4,89	8,17	14,44	19,72	24,28	26,22	25,28	21,28	14,94	7,67	4,00
	7,6200	24,349	IV	0,565	2,834	6,127	12,316	18,369	22,582	24,914	23,994	20,166	14,610	8,380	2,972
	6,0792	18,30		7,61	8,06	10,17	13,56	18,28	23,44	25,91	25,28	22,89	17,94	12,83	8,56
	6,0800	19,428	IV	5,609	7,419	10,047	14,985	19,815	23,176	25,036	24,303	21,248	16,815	11,844	7,529
	5,7275	17,78		10,44	11,83	14,33	18,17	22,50	26,33	28,22	27,17	24,78	19,72	14,39	10,83
	5,7300	18,309	III	7,874	9,580	12,056	16,710	21,262	24,430	26,183	25,492	22,613	18,435	13,781	9,684
	5,3056	16,00		10,39	11,78	12,56	16,56	20,94	24,56	26,39	25,78	24,00	19,83	14,67	12,17
	5,3100	16,967	III	9,057	10,638	12,933	17,245	21,464	24,399	26,024	25,383	22,715	18,844	14,503	10,734

No.	Section	PLACE	Latitude $= \varphi$	Longitude $= \lambda$	Height, metres	AUTHORITY	PERIOD		Mean yearly temperat., $= M$	Calcut. yearly temp. composed of			$\Sigma (+ Q'm)$
										temp. at sea-level			
							years	number of years		normal temperat. at lat. φ $= T\varphi$	thermo-geographical component $= t\varphi,\lambda$	correction for Height, 0,50 °C per 100 m.	
	1	2	3	4	5	6	7	8	9	10	11	12	13
107	VIII	Bermuda	32° 20′	64° 50′	-	Dove	bef. 1848	1	+19,6667				3,8130
			32° 17′	64° 14′	37	Chall. Rep.	1870—84	15	21,3158				3,8940
			32° 17′	64° 14′	37	Formulæ	normal	-	18,7374	+18,4059	+0,5165	—0,1850	3,8874
108	VIII	New Orleans	29° 58′	90° 7′	-	Dove	bef. 1848	3	21,0010				4,5426
			29° 58′	90° 4′	16	Chall. Rep.	1870—84	15	20,6408				4,0294
			29° 58′	90° 4′	16	Formulæ	normal	-	18,7013	+19,7363	—0,9550	—0,0800	3,8874
109	VIII	North Atlantic	27° 30′	77° 30′	-	Chall. Rep.	-	$5^2/_3$	23,4033				4,0265
			27° 30′	77° 30′	-	Formulæ	normal	-	21,6117	+21,0698	+0,5419	-	3,8874
110	VIII	Havana	23° 9′	82° 13′	-	Dove	bef. 1848	7	25,0917				-
			23° 8′	82° 23′	19	Chall. Rep.	1858—76	19	25,7975				-
			23° 8′	82° 23′	19	Formulæ	normal	-	23,8804	+23,2016	+0,7738	—0,0950	-
111	VIII	North Atlantic	22° 30′	72° 30′	-	Chall. Rep.	-	$5^2/_3$	25,7275				-
			22° 30′	72° 30′	-	Formulæ	normal	-	24,9779	+23,4850	+1,4929	-	-
112	VIII	St. Croix (Christiansted)	17° 44′	64° 49′	-	Dove	bef. 1848	$1^1/_3$	27,2208				-
			17° 45′	64° 42′	25	Chall. Rep.	1877—85	9	27,1850				-
			17° 45′	64° 42′	25	Met. Inst., Coph.	1887	1	27,1417				-
			17° 45′	64° 42′	25	do.	1889	1	27,4250				-
			17° 45′	64° 42′	25	Formulæ	normal	-	+26,5295	+25,3879	+1,2666	—0,1250	-

	MV	Ampli-tude	Class of cli-mate	Jan. °C	Feb. °C	March °C	April °C	May °C	June °C	July °C	August °C	Septb. °C	Octb. °C	Novbr. °C	Decbr. °C
	14	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
	3,7160	11,10		13,80	14,90	15,20	17,10	20,60	22,90	24,80	24,80	24,90	22,80	18,80	15,90
	3,4035	9,95		17,17	17,00	16,94	18,56	21,06	24,39	26,56	26,89	25,94	23,22	20,17	17,89
	3,4000	10,864	II	13,121	14,134	15,603	18,364	21,065	22,945	23,985	23,575	21,867	19,388	16,608	14,195
	5,2240	16,650		13,750	14,662	19,212	22,540	25,150	27,650	27,900	27,850	26,350	20,950	14,838	11,250
	4,9825	15,78		12,28	14,67	17,00	20,28	23,78	27,06	28,06	27,72	25,56	21,56	16,39	13,33
	5,0200	16,041	III	10,409	11,904	14,073	18,150	22,138	24,914	26,450	25,844	23,322	19,662	15,557	11,994
	3,3467	9,67		18,72	18,78	19,67	22,06	24,83	27,33	28,39	28,17	27,17	24,61	21,61	19,50
	3,3500	10,704	II	16,078	17,076	18,523	21,244	23,905	25,757	26,782	26,378	24,695	22,253	19,514	17,136
	1,6883	5,66		21,88	23,35	23,37	24,79	25,54	27,23	27,47	27,54	26,88	26,02	23,96	23,07
	2,0458	6,16		22,56	22,78	24,28	25,44	27,11	28,56	28,72	28,50	27,78	26,39	24,89	22,56
	-	-	I	-	-	-	-	-	-	-	-	-	-	-	-
	2,0042	5,56		23,00	23,06	23,39	24,06	26,28	27,83	28,56	28,39	28,33	27,00	25,22	23,61
	-	-	I	-	-	-	-	-	-	-	-	-	-	-	-
	0,9774	3,37		25,34	25,70	26,34	26,76	27,46	28,16	28,71	28,67	28,36	27,77	27,28	26,10
	1,1300	3,28		25,56	25,50	25,89	26,83	27,78	28,39	28,44	28,78	28,61	27,89	26,83	25,72
	1,4180	4,6		25,0	24,5	25,3	26,6	27,6	28,1	29,1	28,9	29,1	28,3	27,4	25,8
	0,9708	3,4		25,7	26,4	27,2	28,0	28,3	28,0	28,3	28,7	28,1	28,4	26,7	25,3
	-	-	I	-	-	-	-	-	-	-	-	-	-	-	-

TABLE X.

SHOWING THE NUMERICAL VALUES AND SIGNS OF THE TERM $\frac{6\ Qm}{\Sigma\ (+Qm)}$ AND THE CORRESPONDING THERMAL ORDER OF THE MONTHS FOR THE POLAR AND TEMPERATE ZONE OF BOTH HEMISPHERES, AS WELL AS FOR SEVERAL MAIN PARALLELS OF THE TROPICAL ZONE.

LATITUDE	January	February	March	April	May	June	July	August	Septemb.	Octob.	Novbr.	Decbr.
North of 23° 21′ N.	1,6519	1,3541	0,9220	0,1098	0,6846	1,2375	1,5435	1,4228	0,9204	0,1913	0,6263	1,3360
	12	11	9	7	5	3	1	2	4	6	8	10
lat. 23° 21′ N.	1,5669	1,3225	0,9469	0,1816	0,6408	1,2556	1,6137	1,4703	0,8964	0,1230	0,6760	1,3073
	12	11	9	7	5	3	1	2	4	6	8	10
20° 0′	1,6155	1,3475	0,9396	0,1185	0,7479	1,3898	1,2464	1,3949	1,0180	0,2028	0,6480	1,3308
	12	11	9	7	5	2	3	1	4	6	8	10
17° 30′	1,6765	1,3800	0,9316	0,0380	0,8951	1,4146	1,0198	1,1774	1,1842	0,3090	0,6130	1,3614
	12	11	9	7	5	1	4	3	2	6	8	10
15° 0′	1,7397	1,4074	0,9087	0,0763	1,0946	1,2152	0,7899	0,9595	1,4083	0,4562	0,5563	1,3881
	12	11	9	7	3	2	5	4	1	6	8	10
12° 30′	1,8140	1,4359	0,8724	0,2309	1,3604	1,0074	0,5411	0,7272	1,4789	0,6535	0,4763	1,4015
	12	11	9	7	2	3	6	4	1	5	8	10
10° 0′	1,9136	1,4710	0,8152	0,4580	1,7231	0,7961	0,2705	0,4797	1,3302	0,9424	0,3565	1,4439
	12	11	9	6	1	4	7	5	2	3	8	10
7° 30′	2,0734	1,5250	0,7167	0,8393	1,7032	0,5893	0,0389	0,2108	1,2301	1,4275	0,1544	1,4915
	12	11	9	4	1	5	7	6	3	2	8	10
5° 0′	2,0551	1,4254	0,5027	1,2598	1,4833	0,2430	0,4530	0,1766	0,9556	1,9218	0,1364	1,3871
	12	11	9	3	2	5	8	7	4	1	6	10
2° 30′ N.	1,8380	1,1718	0,2002	1,6411	1,1012	0,1729	0,8839	0,6019	0,5581	2,2300	0,4694	1,1312
	12	11	7	2	3	6	9	8	4	1	5	10
Equator	1,5364	0,8346	0,1838	2,0982	0,7433	0,5598	1,2809	0,9965	0,1877	1,9061	0,8808	0,7920
	12	9	6	1	4	7	11	10	5	2	3	8
2° 30′ S.	1,1427	0,4328	0,5923	2,2246	0,3714	0,9084	1,6148	1,3354	0,1763	1,5195	1,2924	0,3898
	10	8	4	1	5	9	12	11	6	2	3	7
5° 0′	0,7153	0,0090	1,0498	1,8961	0,0450	1,2232	1,9190	1,6441	0,4988	1,1898	1,7576	0,0528
	9	7	4	1	6	10	12	11	8	3	2	5
7° 30′	0,2383	0,3844	1,2753	1,3181	0,2405	1,2995	1,8770	1,6492	0,6956	0,7217	1,8785	0,4219
	7	6	3	2	8	10	12	11	9	4	1	5

10° 0′	0,1272	0,6684	1,4391	0,8950	0,4313	1,3249	1,8091	1,6184	0,8162	0,3860	1,7834	0,7009
	7	5	2	3	8	10	12	11	9	6	1	4
12° 30′	0,4309	0,9081	1,5847	0,6025	0,5428	1,3076	1,7194	1,5574	0,8729	0,1617	1,3755	0,9367
	6	4	1	5	8	10	12	11	9	7	2	3
15° 0′	0,6981	1,1327	1,5060	0,4013	0,6199	1,2957	1,6570	1,5151	0,9122	0,0071	1,0959	1,1588
	5	3	1	6	8	10	12	11	9	7	4	2
17° 30′	0,9330	1,3311	1,2513	0,2510	0,6646	1,2649	1,5834	1,4586	0,9250	0,1036	0,8789	1,3549
	4	2	3	6	8	10	12	11	9	7	5	1
20° 0′	1,1289	1,4958	1,0365	0,1248	0,7015	1,2378	1,5202	1,4098	0,9347	0,1962	0,6965	1,5178
	3	2	4	6	8	10	12	11	9	7	5	1
25° 6′ S.	1,7441	1,3886	0,8955	0,0332	0,7314	1,2177	1,4691	1,3711	0,9443	0,2661	0,5715	1,3674
	1	2	4	6	8	10	12	11	9	7	5	3
South of 25° 6′ S.	1,6519	1,3541	0,9220	0,1098	0,6846	1,2375	1,5435	1,4228	0,9204	0,1913	0,6263	1,3360
	1	2	4	6	8	10	12	11	9	7	5	3

The figures in red denote the positive and in blue (black) the negative value of the coefficients and the corresponding thermal order of the months.

The following figures give the value of the term $\Sigma\ (+Qm)$.

North of 23° 21′ N.	3,8874	Equator	2,8598
lat. 23° 21′ N.	3,7181	lat. 2° 30′ S.	2,6972
20° 0′	4,3012	5° 0′	3,1645
17° 30′	4,2417	7° 30′	3,1940
15° 0′	4,2606	10° 0′	3,3644
12° 30′	4,0569	12° 30′	3,7864
10° 0′	3,4821	15° 0′	3,9840
7° 30′	3,5230	17° 30′	4,4285
5° 0′	3,1221	20° 0′	3,9531
2° 30′ N.	2,6900	25° 6′ S.	3,4403
Equator	2,8598	South of 25° 6′ S.	3,6322

TABLE XI.

COMPARISON OF THE ACTUALLY OBSERVED AND THE CALCULATED NORMAL MONTHLY TEMPERATURE, THE CORRESPONDING METEOROLOGICAL SERIES AND THE TOTAL DISPLACEMENT OF THE MONTHS FOR VARIOUS PLACES, SITUATED IN THE POLAR AND TEMPERATE ZONE OF THE NORTHERN HEMISPHERE.

The data in this table are all taken from the Challenger Reports, and the temperature given in degrees Centigrade.

CLASSIFICATION OF THE TERM $\Sigma\,(\pm\Delta m)$.

$\Sigma\,(\pm\Delta m) = 2{,}00$ to $4{,}00$ °C.

	MV	$\Sigma\,(\pm\Delta m)$
3. Thorshavn	2,64 °C	3,64 °C
9. Copenhagen....	5,73	3,92
10. Hamburg	5,75	3,26
11. Berlin	6,27	3,20
12. Valentia	2,63	3,20
13. London-Greenw.	4,61	3,66
17. Vienna	6,95	3,93
19. Quebec 10,30		2,70
20. Rome	5,55	3.82
21. Chicago.....	8,51	3,04
23. New York.....	8,05	3,89
27. St. Louis.....	8,22	2,60
32. New Orleans ...	5,02	2,50
43. Julianehaab....	5,18	3,46
45. Sitka.....	4,41	2,58

$= 4{,}00$ to $6{,}00$ °C.

	MV	$\Sigma\,(\pm\Delta m)$
4. St Petersburg..	8,61 °C	5,02 °C
5. Christiania	7,06	4,99
8. Moscow.....	9,31	5,84
16. Paris.....	5,25	4,60
18. Buda-Pest.....	7,54	4,37
26. Lisbon	3,50	4,70
28. Athens	6,08	4,03
29. Gibraltar.....	3,69	4,82
31. Jerusalem	5,10	5,42
38. Fort Franklin ..13,55		5,15
39. Godthaab	5,27	4,73
40. Rejkjavik	4,39	4,86
42. Ivigtut	5,31	4,03

$= 6{,}00$ to $9{,}00$ °C.

	MV	$\Sigma\,(\pm\Delta m)$
2. Obdorsk .....11,40 °C		8,55 °C
6. Stockholm.....	6,87	6,24
7 Tomsk 11,78		8,45
14. Moose Factory .11,45		6,83
15. Semipolatinsk ..13,05		8,58
22. Constantinople..	5,86	6,13
24. Madrid	6,31	8,18
30. Bermuda Isl. ..	3,40	7,35
34. Vardö	4,71	6,58
35. Jacobshavn	7,63	9,00
36. Kola	7,80	7,30

$= 9{,}00$ to $12{,}00$ °C.

	MV	$\Sigma\,(\pm\Delta m)$
25. Samarkand	8,12 °C	9,38 °C
41. St. Michaels ...	9,20	10,03
46. Bering Isl.	4,09	9,05

$\Sigma\,(\pm\Delta m)$ over $12{,}00$ °C.

	MV	$\Sigma\,(\pm\Delta m)$
1. Upernivik	8,72 °C	15.26 °C
33. Fort Conger ...14,21		16,80
37. Verchojansk ...21,61		18,05
44. Olekminsk.....17,05		14,50

No.	No. in Tab. IX	No. in Tab. XV	PLACE	Lati-tude	Longi-tude	Height, metres	PERIOD		MV	Total dis-placem.	Temperature, observed and calcul., °C
							years	years specified	°C		
1	90	4	Upernivik	72° 47′	55° 53′ W	12	11	1874—84	8,68 8,72	6	observed, Chall. Rep. calcul., normal the met. series
2	39	11	Obdorsk	66° 31′	66° 35′ E	24	15	1870—84	11,398 11,40	0	observed, Chall. Rep. calcul., normal the met. series
3	61	26	Thorshavn	62° 2′	6° 43′ W	4	15	1870—84	2,644 2,64	6	observed, Chall. Rep. calcul., normal the met. series
4	6	51	St. Petersburg	59° 56′	30° 16′ E	6	15	1870—84	8,858 8,612	2	observed, Chall. Rep. calcul., normal the met. series
5	7	48	Christiania	59° 55′	10° 43′ E	25	15	1870—84	7,175 7,06	2	observed, Chall. Rep. calcul., normal the met. series
6	8	50	Stockholm	59° 20′	18° 4′ E	44	15	1870—84	6,481 6,87	2	observed, Chall. Rep. calcul., normal the met. series
7	44	55	Tomsk	56° 30′	84° 58′ E	77	15	1870—84	12,166 11,78	4	observed, Chall. Rep. calcul., normal the met. series
8	11	52	Moscow	55° 50′	37° 33′ E	155	15	1870—84	9,258 9,312	4	observed, Chall. Rep. calcul., normal the met. series
9	12	49	Copenhagen	55° 41′	12° 36′ E	14	15	1870—84	5,730 5,731	2	observed, Chall. Rep. calcul., normal the met. series
10	15	71	Hamburg	53° 33′	9° 59′ E	26	15	1870—84	5,50 5,75	2	observed, Chall. Rep. calcul., normal the met. series
11	17	72	Berlin	52° 30′	13° 23′ E	41	15	1870—84	6,093 6,27	2	observed, Chall. Rep. calcul., normal the met. series
12	69	67	Valentia	51° 55′	10° 18′ W	7	15	1870—84	2,631 2,63	6	observed, Chall. Rep. calcul., normal the met. series
13	20	69	London—Greenwich	51° 30′	0° 0′	48	15	1870—84	4,542 4,606	2	observed, Chall. Rep. calcul., normal the met. series

	Jan.	Feb.	March	April	May	June	July	August	Septb.	Octb.	Novbr.	Decbr.	YEAR
	—21,00	—23,50	—21,00	—12,22	— 3,78	1,61	4,72	4,11	+ 1,11	— 4,22	— 8,28	—14,61	— 8,08°C.
	—22,49	—19,90	—16,13	— 9,05	— 2,12	2,70	5,37	4,32	— 0,06	— 6,42	—13,55	—19,74	— 8,08
	+ 1,49	— 3,60	— 4,87	— 3,17	— 1,66	— 1,09	— 0,65	— 0,21	+ 1,17	+ 2,20	+ 5,27	+ 5,13	±15,26
	—26,00	—23,78	—15,22	— 9,33	— 3,28	5,89	13,33	11,11	2,00	— 5,39	—15,11	—23,67	— 7,45
	—26,28	—22,89	—17,96	— 8,70	+ 0,35	6,65	10,14	8,77	3,04	— 5,27	—14,59	—22,68	— 7,45
	+ 0,28	— 0,89	+ 2,74	— 0,63	— 3,63	— 0,76	+ 3,19	+ 2,34	— 1,04	— 0,12	— 0,52	— 0,99	± 8,55
	3,33	3,50	3,39	5,22	7,06	9,50	10,94	11,00	9,22	6,78	4,22	3,11	+ 6,44
	2,09	2,87	4,01	6,15	8,25	9,70	10,52	10,20	8,87	6,95	4,79	2,91	+ 6,44
	+ 1,24	+ 0,63	— 0,62	— 0,93	— 1,19	— 0,20	+ 0,42	+ 0,80	+ 0,35	— 0,17	— 0,57	+ 0,20	± 3,64
	— 8,22	— 8,61	— 4,33	1,72	8,28	15,50	17,61	15,78	10,89	4,56	— 1,06	— 7,17	+ 3,74
	—10,48	— 7,92	— 4,20	2,80	9,64	14,40	17,03	15,99	11,67	5,39	— 1,55	— 7,76	+ 3,74
	+ 2,26	— 0,69	— 0,13	— 1,08	— 1,36	+ 1,10	+ 0,58	— 0,21	— 0,78	— 0,83	+ 0,49	+ 0,59	± 5,02
	— 4,28	— 4,61	— 1,50	4,00	9,78	15,61	17,11	15,78	11,22	5,06	0,06	— 4,61	+ 5,30
	— 6,36	— 4,25	— 1,21	4,53	10,13	14,04	16,20	15,35	11,80	6,65	0,88	— 4,13	+ 5,30
	+ 2,08	— 0,36	— 0,29	— 0,53	— 0,35	+ 1,57	+ 0,91	+ 0,43	— 0,58	— 1,59	— 0,82	— 0,48	± 4,99
	— 2,61	— 3,28	— 1,61	2,61	7,94	14,11	16,67	15,28	11,44	5,61	0,89	— 2,72	+ 5,36
	— 5,99	— 3,94	— 0,97	4,61	10,06	13,86	15,96	15,14	11,68	6,68	1,06	— 3,82	+ 5,36
	+ 3,38	+ 0,66	— 0,64	— 2,00	— 2,12	+ 0,25	+ 0,71	+ 0,14	— 0,24	— 1,07	— 0,17	+ 1,10	± 6,24
	—19,72	—18,06	— 8,83	— 1,17	8,72	15,44	19,72	15,78	9,22	0,61	—10,33	—18,39	— 0,58
	—20,04	—16,54	—11,44	— 1,88	7,48	13,99	17,60	16,18	10,26	1,67	— 7,96	—16,32	— 0,58
	+ 0,32	— 1,52	+ 2,61	+ 0,71	+ 1,24	+ 1,45	+ 2,12	— 0,40	— 1,04	— 1,06	— 2,37	— 2,07	± 8,45
	—10,50	—10,28	— 4,61	2,89	11,61	17,33	19,00	16,39	10,44	4,22	— 1,39	— 8,22	+ 3,90
	—11,48	— 8,71	— 4,68	2,88	10,28	15,43	18,27	17,15	12,47	5,68	— 1,93	— 8,54	+ 3,90
	+ 0,98	— 1,57	+ 0,07	+ 0,01	+ 1,33	+ 1,90	+ 0,73	— 0,76	— 2,03	— 1,46	+ 0,54	+ 0,32	± 5,84
	0,06	— 0,72	1,39	5,61	9,89	14,67	16,72	16,22	12,94	8,44	3,72	0,06	+ 7,42
	— 2,05	— 0,34	2,14	6,79	11,35	14,51	16,27	15,57	12,69	8,52	3,83	— 0,24	+ 7,42
	+ 2,11	— 0,38	— 0,75	— 1,18	— 1,46	+ 0,16	+ 0,45	+ 0,65	+ 0,25	— 0,08	— 0,11	+ 0,30	± 3,92
	0,61	1,17	3,56	7,33	11,17	15,44	17,44	16,89	13,67	8,72	4,00	0,67	+ 8,39
	— 1,11	0,60	3,09	7,76	12,33	15,50	17,26	16,57	13,68	9,49	4,79	0,70	+ 8,39
	+ 1,72	+ 0,57	+ 0,47	— 0,43	— 1,16	— 0,06	+ 0,18	+ 0,32	— 0,01	— 0,77	— 0,79	— 0,03	± 3,26
	0,44	0,89	3,89	8,39	12,61	17,17	19,28	18,28	14,83	9,39	4,39	0,44	+ 9,17
	— 1,19	0,68	3,39	8,48	13,46	16,93	18,85	18,09	14,94	10,37	5,24	0,79	+ 9,17
	+ 1,63	+ 0,21	+ 0,50	— 0,09	— 0,85	+ 0,24	+ 0,43	+ 0,19	— 0,11	— 0,98	— 0,85	— 0,35	± 3,20
	7,39	7,50	7,94	9,44	11,56	13,50	14,83	15,28	13,67	11,11	8,67	7,44	+10,69
	6,35	7,13	8,27	10,40	12,49	13,95	14,75	14,43	13,12	11,20	9,00	7,13	+10,69
	+ 1,04	+ 0,37	— 0,33	— 0,96	— 0,93	— 0,45	+ 0,08	+ 0,85	+ 0,55	— 0,09	— 0,33	+ 0,31	± 3,20
	3,78	4,67	5,72	9,00	12,22	15,78	17,56	17,39	14,72	10,50	6,11	4,39	+10,16
	2,55	3,92	5,91	9,65	13,31	15,86	17,27	16,71	14,40	11,04	7,27	4,00	+10,16
	+ 1,23	+ 0,75	— 0,19	— 0,65	— 1,09	— 0,08	+ 0,29	+ 0,68	+ 0,32	— 0,54	— 1,16	+ 0,39	± 3,66

No.	No. in Tab. IX	No. in Tab. XV	PLACE	Lati-tude	Longi-tude	Height, metres	PERIOD		MV	Total dis-placem.	Temperature, observed and calcul., °C
							years	years specified	°C		
14	95	62	Moose Factory	51° 15′	80° 45′ W	10	24	1857—80	11,449 11,45	0	observed, Chall. Rep. calcul., normal the met. series
15	49	104	Semipolatinsk	50° 24′	80° 13′ E	181	15	1870—84	13,050 13,050	4	observed, Chall. Rep. calcul., normal the met. series
16	22	95	Paris	48° 50′	2° 21′ E	78	15	1870—84	4,907 5,248	6	observed. Chall. Rep. calcul., normal the met. series
17	23	98	Vienna	48° 14′	16° 22′ E	202	15	1870—84	6,658 6,946	6	observed, Chall. Rep. calcul., normal the met. series
18	24	99	Buda-Pest	47° 30′	19° 2′ E	153	15	1870—84	7,230 7,54	6	observed, Chall. Rep. calcul., normal the met. series
19	97	87	Quebec	46° 48′	71° 12′ W	95	15	1870—84	10,213 10,30	0	observed, Chall. Rep. calcul., normal the met. series
20	29	124	Rome	41° 54′	12° 29′ E	50	15	1870—84	5,561 5,55	2	observed, Chall. Rep. calcul., normal the met. series
21	99	111	Chicago	41° 52′	87° 38′ W	201	15	1870—84	8,509 8,51	2	observed, Chall. Rep. calcul., normal the met. series
22	30	128	Constantinople	41° 0′	28° 59′ E	-	15	1870—84	5,861 5,86	4	observed, Chall. Rep. calcul., normal the met. series
23	100	112	New York	40° 43′	74° 0′ W	50	15	1870—84	8,046 8,05	0	observed, Chall. Rep. calcul., normal the met. series
24	78	119	Madrid	40° 22′	3° 42′ W	655	15	1870—84	6,31 6,31	6	observed, Chall. Rep. calcul., normal the met. series
25	53	165	Samarkand	39° 39′	66° 57′ E	725	15	1870—84	8,12 8,12	8	observed, Chall. Rep. calcul., normal the met. series
26	79	151	Lisbon	38° 42′	9° 8′ W	102	15	1870—84	3,43 3,50	10	observed, Chall. Rep. calcul., normal the met. series

	Jan.	Feb.	March	April	May	June	July	August	Septb.	Octb.	Novbr.	Decbr.	YEAR
	—20,28	—18,78	—11,67	— 3,89	5,11	11,22	15,61	14,44	9,22	3,78	— 5,89	—17,50	— 1,55°C.
	—20,47	—17,06	—12,11	— 2,81	6,29	12,62	16,12	14,74	8,99	0,64	— 8,72	—16,85	— 1,55
	+ 0,19	— 1,72	+ 0,44	— 1,08	— 1,18	— 1,40	— 0,51	— 0,30	+ 0,23	+ 3,14	+ 2,83	— 0,65	± 6,83
	—18,00	—16,22	— 7,72	2,94	14,89	20,28	23,22	20,22	13,00	3,39	— 7,22	—15,11	+ 2,81
	—18,75	—14,86	— 9,23	1,37	11,74	18,95	22,95	21,37	14,82	5,30	— 5,37	—14,63	+ 2,81
	+ 0,75	— 1,36	+ 1,51	+ 1,57	+ 3,15	+ 1,33	+ 0,27	— 1,15	— 1,82	— 1,91	— 1,85	— 0,48	± 8,58
	2,89	4,56	7,00	10,17	13,00	16,56	18,89	18,33	15,00	10,22	6,22	2,78	+10,47
	1,81	3,37	5,64	9,90	14,07	16,97	18,58	17,94	15,31	11,48	7,19	3,47	+10,47
	+ 1,08	+ 1,19	+ 1,36	+ 0,27	— 1,07	— 0,41	+ 0,31	+ 0,39	— 0,31	— 1,26	— 0,97	— 0,69	± 4,60
	— 1,33	0,22	4,61	9,50	13,67	17,89	20,28	18,89	15,06	10,00	3,72	— 0,50	+ 9,33
	— 2,14	— 0,07	2,93	8,57	14,09	17,93	20,06	19,22	15,73	10,66	4,98	+ 0,05	+ 9,33
	+ 0,81	+ 0,29	+ 1,68	+ 0,93	— 0,42	— 0,04	+ 0,22	— 0,33	— 0,67	— 0,66	— 1,26	— 0,55	± 3,93
	— 1,44	— 0,22	4,78	10,67	15,06	19,28	21,72	20,28	15,89	10,39	4,00	— 0,56	+ 9,99
	— 2,47	— 0,22	3,04	9,16	15,15	19,32	21,63	20,72	16,93	11,43	5,27	— 0,09	+ 9,99
	+ 1,03	0	+ 1,74	+ 1,51	— 0,09	— 0,04	+ 0,09	— 0,44	— 1,04	— 1,04	— 1,27	— 0,47	± 4,37
	—12,72	—10,28	— 5,78	1,83	9,72	16,56	19,17	18,17	13,50	6,50	— 2,00	— 9,72	+ 3,75
	—13,27	—10,20	— 5,75	2,61	10,79	16,49	19,64	18,40	13,22	5,71	— 2,71	—10,02	+ 3,75
	+ 0,55	— 0,08	— 0,03	— 0,78	— 1,07	+ 0,07	— 0,47	— 0,23	+ 0,28	+ 0,79	+ 0,71	+ 0,30	± 2,70
	7,11	8,33	10,50	14,22	17,78	21,39	24,78	24,50	21,22	16,61	11,39	8,00	+15,49
	6,32	7,97	10,37	14,87	19,28	22,35	24,05	23,38	20,59	16,55	12,01	8,07	+15,49
	+ 0,79	+ 0,36	+ 0,13	— 0,65	— 1,50	— 0,96	+ 0,73	+ 1,12	+ 0,63	+ 0,06	— 0,62	— 0,07	± 3,82
	— 3,61	— 1,50	1,89	7,94	14,17	19,83	22,72	22,33	18,00	11,89	3,78	— 1,67	+ 9,65
	— 4,41	— 1,88	1,80	8,71	15,47	20,18	22,78	21,75	17,48	11,27	4,31	— 1,72	+ 9,65
	+ 0,80	+ 0,38	+ 0,09	— 0,77	— 1,30	— 0,35	— 0,06	+ 0,58	+ 0,52	+ 0,62	— 0,53	+ 0,05	± 3,04
	5,39	5,00	7,39	12,22	16,61	21,11	23,28	23,22	20,00	16,33	11,89	8,33	+14,23
	4,55	6,29	8,82	13,58	18,24	21,48	23,27	22,56	19,62	15,35	10,56	6,40	+14,23
	+ 0,84	— 1,29	— 1,43	— 1,36	— 1,63	— 0,37	+ 0,01	+ 0,66	+ 0,38	+ 0,98	+ 1,33	+ 1,93	± 6,13
	— 0,94	— 0,17	2,56	8,44	15,11	20,50	23,11	22,39	18,67	13,17	6,00	0,67	+10,79
	— 2,50	— 0,11	3,37	9,91	16,30	20,75	23,22	22,25	18,20	12,33	5,75	0,04	+10,79
	+ 1,56	— 0,06	— 0,81	— 1,47	— 1,19	— 0,25	— 0,11	+ 0,14	+ 0,47	+ 0,84	+ 0,25	+ 0,63	± 3,89
	4,50	6,50	9,00	11,83	15,83	20,50	25,22	24,89	19,50	13,28	8,28	4,06	+13,62
	3,19	5,07	7,80	12,92	17,94	21,42	23,36	22,59	19,42	14,82	9,66	5,19	+13,62
	+ 1,31	+ 1,43	+ 1,20	— 1,09	— 2,11	— 0,92	+ 1,86	+ 2,30	+ 0,08	— 1,54	— 1,38	— 1,13	± 8,18
	— 0,67	1,39	9,00	14,44	21,67	25,56	27,72	25,11	18,89	13,50	8,17	4,56	+14,11
	+ 0,70	3,11	6,62	13,22	19,67	24,16	26,64	25,66	21,58	15,66	9,02	3,26	+14,11
	— 1,37	— 1,72	+ 2,38	+ 1,22	+ 2,00	+ 1,40	+ 1,08	— 0,55	— 2,69	— 2,16	— 0,85	+ 1,30	± 9,38
	10,44	11,28	12,39	14,28	16,39	17,94	21,11	21,50	19,89	16,67	13,67	10,28	+15,49
	9,71	10,75	12,26	15,10	17,88	19,82	20,89	20,47	18,71	16,16	13,30	10,81	+15,49
	+ 0,73	+ 0,53	+ 0,13	— 0,82	— 1,49	— 1,88	+ 0,22	+ 1,03	+ 1,18	+ 0,51	+ 0,37	— 0,53	± 4,70

No.	No. in Tab. IX	No. in Tab. XV	PLACE	Lati-tude	Longi-tude	Height, metres	PERIOD		MV °C	Total dis-placem.	Temperature, observed and calcul., °C
							years	years specified			
27	101	143	St. Louis	38° 27′	90° 12′ W	174	15	1870—84	8,338 8,22	2	observed, Chall. Rep. calcul., normal the met. series
28	31	159	Athens	37° 58′	23° 44′ E	103	24	1859—82	6,082 6,08	0	observed, Chall. Rep. calcul., normal the met. series
29	83	152	Gibraltar	36° 8′	5° 20′ W	16	15	1870—84	3,689 3,69	10	observed, Chall. Rep. calcul., normal the met. series
30	107	181a	Bermuda	32° 17′	64° 14′ W	37	15	1870—84	3,404 3,40	12	observed, Chall. Rep. calcul., normal the met. series
31	36	193	Jerusalem	31° 47′	35° 13′ E	732	19	1863—81	5,098 5,10	4	observed, Chall. Rep. calcul., normal the met. series
32	108	177	New Orleans	29° 58′	90° 4′ W	16	15	1870—84	4,983 5,02	4	observed, Chall. Rep. calcul., normal the met. series
			SUPPLEMENTARY POLAR AND NORTHERN STATIONS.								
33	-	3	Fort Conger	81° 44′	64° 45′ W	0	2	1881—83	14,21 14,21	6	observed, Chall. Rep. calcul., normal the met. series
34	1	9	Vardö	70° 22′	31° 7′ E	10	15	1870—84	4,713 4,71	10	observed, Chall. Rep. calcul., normal the met. series
35	91	5	Jacobshavn	69° 13′	50° 55′ W	13	11	1874—84	7,612 7,63	4	observed, Chall. Rep. calcul., normal the met. series
36	2	10	Kola	68° 53′	33° 1′ E	10	15	1870—84	7,801 7,80	4	observed, Chall. Rep. calcul., normal the met. series
37	-	13	Werchojansk	67° 34′	133° 51′ E	140	5	various	21,61 21,61	6	observed, Chall. Rep. calcul., normal the met, series
38	-	17	Fort Franklin	65° 12′	123° 13′ W	152	1 3/4	?	13,55 13,55	0	observed, Chall. Rep. calcul., normal the met. series

	Jan.	Feb.	March	April	May	June	July	August	Septb.	Octb.	Novbr.	Decbr.	YEAR
	— 0,50	2,22	6,17	13,06	18,94	23,72	25,78	24,89	20,67	14,56	6,33	1,22	+13,09°C.
	— 0,49	1,96	5,51	12,19	18,72	23,26	25,78	24,78	20,65	14,66	7,94	2,11	+13,09
	— 0,01	+ 0,26	+ 0,66	+ 0,87	+ 0,22	+ 0,46	0	+ 0,11	+ 0,02	— 0,10	— 1,61	— 0,89	± 2,60
	8,00	8,78	11,33	15,06	19,94	24,44	27,00	26,67	23,33	18,78	14,06	9,94	+17,28
	7,23	9,04	11,67	16,61	21,44	24,80	26,66	25,93	22,87	18,44	13,47	9,15	+17,28
	+ 0,77	— 0,26	— 0,34	— 1,55	— 1,50	— 0,36	+ 0,34	+ 0,74	+ 0,46	+ 0,34	+ 0,59	+ 0,79	± 4,03
	13,61	14,00	14,67	17,22	18,94	22,11	24,56	25,28	22,89	19,44	16,28	13,17	+18,51
	12,42	13,52	15,11	18,11	21,04	23,08	24,21	23,76	21,91	19,22	16,20	13,58	+18,51
	+ 1,19	+ 0,48	— 0,44	— 0,89	— 2,10	— 0,97	+ 0,35	+ 1,52	+ 0,98	+ 0,22	+ 0,08	— 0,41	± 4,82
	17,17	17,00	16,94	18,56	21,06	24,39	26,56	26,89	25,94	23,22	20,17	17,89	+21,32
	15,70	16,71	18,18	20,94	23,65	25,52	26,56	26,15	24,44	21,97	19,19	16,77	+21,32
	+ 1,47	+ 0,29	— 1,24	— 2,38	— 2,59	— 1,13	0	+ 0,74	+ 1,50	+ 1,25	+ 0,98	+ 1,12	± 7,35
	8,78	9,11	12,39	15,83	20,22	22,78	23,39	24,17	22,61	20,72	15,61	11,00	+17,22
	8,79	10,31	12,50	16,65	20,71	23,56	25,09	24,47	21,91	18,19	14,02	10,40	+17,22
	— 0,01	— 1,20	— 0,11	— 0,82	— 0,49	— 0,78	— 1,70	— 0,30	+ 0,70	+ 2,53	— 1,59	+ 0,60	± 5,42
	12,28	14,67	17,00	20,28	23,78	27,06	28,06	27,72	25,56	21,56	16,39	13,33	+20,64
	12,35	13,84	16,01	20,09	24,08	26,85	28,39	27,78	25,26	21,60	17,50	13,94	+20,64
	— 0,07	+ 0,83	+ 0,99	+ 0,17	— 0,30	+ 0,21	— 0,33	— 0,06	+ 0,30	— 0,04	— 1,11	— 0,61	± 2,50
	—38,56	—41,50	—31,67	—24,83	— 9,11	+ 0,17	2,50	1,22	— 9,89	—22,22	—32,61	—34,33	—20,07
	—43,54	—39,31	—33,17	—21,63	—10,34	— 2,48	+ 1,86	0,15	— 6,99	—17,35	—28,97	—39,06	—20,07
	+ 4,98	— 2,19	+ 1,50	— 3,20	+ 1,23	+ 2,65	+ 0,64	+ 1,07	— 2,90	— 4,87	— 3,64	+ 4,73	±16,80
	— 5,06	— 6,11	— 4,72	— 2,00	1,11	5,33	8,39	8,72	5,89	1,61	— 2,50	— 5,11	+ 0,46
	— 7,32	— 5,92	— 3,88	+ 0,06	3,69	6,29	7,69	7,16	4,80	1,36	— 2,49	— 5,83	+ 0,46
	+ 2,26	— 0,19	— 0,84	— 2,06	— 2,58	— 0,96	+ 0,70	+ 1,56	+ 1,09	+ 0,25	— 0,01	+ 0,72	± 6,58
	—15,78	—17,78	—15,67	— 7,39	— 0,22	4,72	7,50	6,11	1,89	— 3,78	— 7,39	—11,11	— 4,91
	—17,51	—15,24	—11,94	— 5,75	+ 0,32	4,53	6,87	5,95	2,11	— 3,45	— 9,69	—15,10	— 4,91
	+ 1,73	— 2,54	— 3,73	— 1,64	— 0,54	+ 0,19	+ 0,63	+ 0,16	— 0,22	— 0,33	+ 2,30	+ 3,99	± 9,00
	—10,56	—11,78	— 6,94	— 2,06	3,11	9,61	13,22	11,89	6,11	— 0,28	— 7,83	—10,78	— 0,52
	—13,41	—11,09	— 7,72	— 1,38	4,82	9,13	11,52	10,57	6,66	+ 0,97	— 5,41	—10,95	— 0,52
	+ 2,85	— 0,69	+ 0,78	— 0,68	— 1,71	+ 0,48	+ 1,70	+ 1,32	— 0,55	— 1,25	— 2,42	+ 0,17	± 7,30
	—51,78	—46,61	—34,33	—15,56	+ 0,22	10,78	14,78	9,28	0,39	—18,11	—39,72	—48,61	—18,27
	—53,97	—47,53	—38,19	—20,64	— 3,47	8,47	15,08	12,48	1,62	—14,14	—31,80	—47,14	—18,27
	+ 2,19	+ 0,92	+ 3,86	+ 5,08	+ 3,69	+ 2,31	— 0,30	— 3,20	— 1,23	— 3,97	— 7,92	— 1,47	±18,05
	—30,17	—27,06	—20,78	—10,94	1,78	8,89	11,17	10,33	5,00	— 5,33	—17,89	—23,83	— 8,24
	—30,62	—26,59	—20,73	— 9,73	1,04	8,53	12,67	11,04	4,23	— 5,65	—16,73	—26,34	— 8,24
	+ 0,45	— 0,47	— 0,05	— 1,21	+ 0,74	+ 0,36	— 1,50	— 0,71	+ 0,77	+ 0,32	— 1,16	+ 2,51	± 5,15

No.	No. in Tab. IX	No. in Tab. XV	PLACE	Lati-tude	Longi-tude	Height, metres	PERIOD		MV °C	Total dis-placem.	Temperature, observed and calcul., °C
							years	years specified			
39	92	20	Godthaab	64° 11′	51° 45′ W	11	11	1874—84	5,185 5,27	4	observed, Chall. Rep. calcul., normal the met. series
40	-	24	Rejkjavik	64° 9′	22° 0′ W	7	15	1870—84	4,39 4,39	4	observed, Chall. Rep. calcul., normal the met. series
41	-	16	St. Michaels	63° 48′	161° 0′ W	10	14	1842—86	9,20 9,20	4	observed, Chall. Rep. calcul., normal the met. series
42	62	21	Ivigtut	61° 12′	48° 11′ W	5	11	1874—84	5,420 5,31	2	observed, Chall. Rep. calcul., normal the met. series
43	-	22	Juliancehaab	60° 44′	45° 59′ W	8	11	1874—84	5,18 5,18	6	observed, Chall. Rep. calcul., normal the met. series
44	-	39	Olekminsk	60° 22′	120° 26′ E	122	15	1870—84	17,05 17,05	6	observed, Chall. Rep. calcul., normal the met. series
45	-	42	Sitka	57° 3′	135° 19′ W	5	43	1832—76	4,41 4,41	2	observed, Chall. Rep. calcul., normal the met. series
46	-	58	Bering Island	55° 12′	165° 55′ E	6	4	1882—86	4,19 4,19	14	observed, Chall. Rep. calcul., normal the met. series

Jan.	Feb.	March	April	May	June	July	August	Septb.	Octb.	Novbr.	Decbr.	YEAR
— 9,72	—10,00	— 8,28	— 3,00	1,00	4,61	6,78	6,11	3,11	— 1,39	— 3,78	— 7,22	— 1,82 °C.
—10,52	— 8,95	— 6,67	— 2,39	1,79	4,71	6,32	5,68	3,04	— 0,81	— 5,12	— 8,85	— 1,82
+ 0,80	— 1,05	— 1,61	— 0,61	— 0,79	— 0,10	+ 0,46	+ 0,43	+ 0,07	— 0,58	+ 1,34	+ 1,63	± 4,73
— 1,50	— 1,39	— 1,44	3,17	6,44	10,33	11,94	10,94	7,94	4,28	0,83	— 0,56	+ 4,25
— 3,00	— 1,69	+ 0,20	3,77	7,26	9,68	11,03	10,50	8,29	5,09	1,50	— 1,62	+ 4,25
+ 1,50	+ 0,30	— 1,64	— 0,60	— 0,82	+ 0,65	+ 0,91	+ 0,44	— 0,35	— 0,81	— 0,67	+ 1,06	± 4,86
—14,89	—17,78	—13,89	— 6,56	1,44	7,56	12,11	11,33	6,67	— 0,56	— 7,78	—13,44	— 2,98
—18,18	—15,44	—11,46	— 3,99	3,32	8,41	11,22	10,11	5,49	— 1,22	— 8,74	—15,27	— 2,98
+ 3,29	— 2,34	— 2,43	— 2,57	— 1,88	— 0,85	+ 0,89	+ 1,22	+ 1,18	+ 0,66	+ 0,96	+ 1,83	±10,03
— 7,61	— 8,11	— 5,00	0,89	4,78	8,22	9,72	8,33	5,22	1,22	— 2,61	— 5,00	+ 0,84
— 7,93	— 6,35	— 4,06	0,25	4,47	7,41	9,03	8,39	5,72	1,85	— 2,49	— 6,26	+ 0,84
+ 0,32	— 1,76	— 0,94	+ 0,64	+ 0,31	+ 0,81	+ 0,69	— 0,06	— 0,50	— 0,63	— 0,12	+ 1,26	± 4,03
— 7,50	— 7,61	— 5,00	0,83	4,44	7,56	8,17	8,22	5,89	2,33	— 2,11	— 4,22	+ 0,92
— 7,64	— 6,09	— 3,86	0,35	4,47	7,33	8,92	8,29	5,69	1,91	— 2,32	— 6,00	+ 0,92
+ 0,14	— 1,52	— 1,14	+ 0,48	— 0,03	+ 0,23	— 0,75	— 0,07	+ 0,20	+ 0,42	+ 0,21	+ 1,78	± 3,46
—36,11	—28,56	—16,83	— 5,72	5,72	15,28	19,22	14,61	6,89	— 4,78	—22,94	—34,33	— 7,30
—35,47	—30,39	—23,02	— 9,17	4,37	13,80	19,02	16,96	8,39	— 4,04	—17,98	—30,08	— 7,30
— 0,64	+ 1,83	+ 6,19	+ 3,45	+ 1,35	+ 1,48	+ 0,20	— 2,35	— 1,50	— 0,74	— 4,96	— 4,25	±14,50
— 0,33	0,50	2,00	4,89	8,33	11,33	13,06	13,28	10,83	7,17	3,39	0,72	+ 6,26
— 1,03	0,29	2,19	5,78	9,28	11,72	13,07	12,54	10,32	7,10	3,50	0,37	+ 6,26
+ 0,70	+ 0,21	— 0,19	— 0,89	— 0,95	— 0,39	— 0,01	+ 0,74	+ 0,51	+ 0,07	— 0,11	+ 0,35	± 2,58
— 3,11	— 2,33	— 2,44	— 1,33	2,22	5,44	8,11	10,56	8,17	3,17	— 1,00	— 2,44	+ 2,09
— 4,83	— 3,58	— 1,77	+ 1,63	4,96	7,28	8,56	8,05	5,95	2,89	— 0,53	— 3,51	+ 2,09
+ 1,72	+ 1,25	— 0,67	— 2,96	— 2,74	— 1,84	— 0,45	+ 2,51	+ 2,22	+ 0,28	— 0,47	+ 1,07	± 9,05

TABLE XII.

COMPARISON OF THE ACTUALLY OBSERVED AND THE CALCULATED NORMAL MONTHLY TEMPERATURE, THE CORRESPONDING METEOROLOGICAL SERIES AND THE TOTAL DISPLACEMENT OF THE MONTHS FOR VARIOUS PLACES, SITUATED IN OR NEAR SEVERAL MAIN PARALLELS OF THE TROPICAL ZONE.

The data in this table are all taken from the Challenger Reports, and the temperature given in degrees Fahrenheit and Centigrade.

CLASSIFICATION OF THE TERM $\Sigma(\pm\Delta m)$.

$\Sigma(\pm\Delta m) = 0$ to $2{,}00$°C.

		MV	$\Sigma(\pm\Delta m)$
1.	Havana	2,05 °C	1,61 °C
7.	Christiansted	1,13	1,51
13.	Barbadoes	0,55	0,78
15.	Red Sea	1,75	1,87
21.	Colon	0,25	1,87
22.	Caraccas	0,86	1,57
23.	St. Anns Trd.	0,50	1,49
31.	Malacca	0,26	1,91
37.	Palembang	0,24	1,15
39.	Rubaga	0,45	2,00
48.	Iquique	1,85	1,83

$= 2{,}00$ to $4{,}00$°C.

		MV	$\Sigma(\pm\Delta m)$
6.	Kingston	0,98 °C	2,69 °C
11.	Red Sea	2,34	3,59
16.	Aden	2,14	3,32
27.	Cayenne	0,52	2,46
32.	Quito	0,42	3,44
36.	Porto do Maranho	0,35	2,65
41.	Somerset, C. York	0,90	2,74
43.	St. B. das Lagos	1,45	2,26
44.	Bahia	1,35	2,64
45.	Port Darwin	1,39	3,88
47.	Tahiti	0,89	2,84
49.	St. Denis	1,82	2,63
50.	Mauritius	1,89	3,10
51.	Rodriguez	1,86	3,40
53.	Ravenswood	2,82	2,96
57.	Lorenço Marquez	2,63	3,95

$= 4{,}00$ to $6{,}00$°C.

		MV	$\Sigma(\pm\Delta m)$
9.	Visagapatam	2,04 °C	5,87 °C
10.	Praya	1,38	5,40
12.	Manila	0,91	4,29
19.	Madras	2,04	5,42
20.	San José	0,79	5,98
25.	Kandy	0,71	4,06
26.	Batticalao	1,27	4,70
33.	Antisana	0,88	5,33
34.	St. Thomas	0,58	4,18
35.	Gabun	0,85	5,70
38.	Chinchoxo	1,42	5,40
42.	Callao	2,13	4,64
46.	Sweers Island	2,58	4,73
52.	Cossack	3,85	5,83
56.	Pretoria	2,23	4,96

$= 6{,}00$ to $9{,}00$°C.

		MV	$\Sigma(\pm\Delta m)$
2.	Red Sea	2,38 °C	6,52 °C
3.	Mascat	3,94	7,36
5.	Akyab	2,13	8,16
17.	Mangalore	1,01	8,06
24.	Cochin	0,92	8,20
30.	Penang	0,77	6,38
40.	Ascension	1,06	7,54
54.	Salta	3,29	7,11
55.	Assuncion	3,72	6,03

$\Sigma(\pm\Delta m) = 9{,}00$ to $12{,}00$°C.

		MV	$\Sigma(\pm\Delta m)$
18.	Bangalore	1,70 °C	10,11 °C
28.	Christiansborg	1,08	9,39

$=$ over $12{,}00$°C.

		MV	$\Sigma(\pm\Delta m)$
4.	Cuttack	2,81 °C	13,63 °C
8	Secunderabad	2,56	16,63
14.	Kouka	2,85	13,30
29.	Lado	1,39	15,06

No.	No. in Tab. XV	Parallel	PLACE	Latitude	Longitude	Height, merres	PERIOD		MV	Total displacem.	Temperature, observed and calcul.,
							years	years specified			
1	223	23° 21′ N	Havana	23° 8′ N	82° 23′ W	19	19	1858—76	3,687 °F 2,05 °C	4	observed, Chall. Rep. calcul., normal the met. series
2	228	-	Red Sea	23° 0′ N	37° 0′ E	-	-	-	4,277 2,38	16	observed, Chall. Rep. calcul., normal the met. series
3	229	-	Mascat	23° 38′ N	58° 36′ E	10	3 3/4	various	7,087 3,93	10	observed, Chall. Rep. calcul., normal the met. series
4	238	20° 0′ N	Cuttack	20° 9′ N	85° 54′ E	24	15	1870—84	5,053 2,81	28	observed, Chall. Rep. calcul., normal the met. series
5	239	-	Akyab	20° 28′ N	92° 54′ E	6	15	1870—84	3,833 2,13	28	observed, Chall. Rep. calcul., normal the met. series
6	240	17° 30′ N	Kingston	18° 1′ N	76° 48′ W	3	8	1880—87	1,763 0,98	14	observed, Chall. Rep. calcul., normal the met. series
7	241	-	Christiansted	17° 45′ N	64° 42′ W	25	9	1877—85	2,037 1,13	12	observed, Chall. Rep. calcul., normal the met. series
8	247	-	Secunderabad	17° 27′ N	78° 33′ E	545	15	1870—84	4,820 2,56	36	observed, Chall. Rep. calcul.. normal the met. series
9	248	-	Visagapatam	17° 42′ N	83° 22′ E	10	15	1870—84	3,627 2,04	22	observed, Chall. Rep. calcul., normal the met. series
10	250	15° 0′ N	Praya	14° 54′ N	23° 31′ W	34	5	1875—79	2,480 1,38	24	observed. Chall. Rep. calcul., normal the met. series
11	251	-	Red Sea	15° 0′ N	42° 0′ E	-	-	-	4,213 2,34	12	observed, Chall. Rep. calcul., normal the met. series
12	252	-	Manila	14° 35′ N	120° 59′ E	17	15	1870—84	1,642 0,91	26	observed, Chall. Rep. calcul., normal the met. series
13	253	12° 30′ N	Barbadoes	13° 4′ N	59° 40′ W	8	15	1870—84	0,993 0,55	8	observed, Chall. Rep. calcul., normal the met. series

Jan.	Feb.	March	April	May	June	July	August	Septb.	Octb.	Novbr.	Decbr.	YEAR
72,6	73,0	75,7	77,8	80,8	83,4	83,7	83,3	82,0	79,5	76,8	72,6	78,43 °F
72,65	73,55	74,94	77,76	80,79	83,06	84,38	83,85	81,74	78,88	75,94	73,61	78,43
− 0,05	− 0,55	+ 0,76	+ 0,04	+ 0,01	+ 0,34	− 0,68	− 0,55	+ 0,26	+ 0,62	+ 0,86	− 1,01	± 2,89 = 1,61 °C
73,1	72,8	75,3	77,9	81,0	83,0	85,9	87,6	86,0	84,2	80,9	77,3	80,42
73,72	74,77	76,37	79,64	83,16	85,79	87,32	86,71	84,25	80,95	77,53	74,83	80,42
− 0,62	− 1,97	− 1,07	− 1,74	− 2,16	− 2,79	− 1,42	+ 0,89	+ 1,75	+ 3,25	+ 3,37	+ 2,47	±11,73 = 6,52
68,6	69,8	75,0	80,8	89,9	91,8	88,3	86,9	85,3	84,0	77,1	70,2	80,64
69,53	71,27	73,93	79,35	85,18	89,54	92,08	91,06	86,99	81,51	75,85	71,37	80,64
− 0,93	− 1,47	+ 1,07	+ 1,45	+ 4,72	+ 2,26	− 3,78	− 4,16	− 1,69	+ 2,49	+ 1,25	− 1,17	±13,24 = 7,36
71,5	76,0	83,0	87,4	88,6	86,2	83,2	83,2	83,1	81,3	75,0	70,0	80,71
72,55	73,90	75,96	80,11	84,49	87,73	87,01	87,76	85,85	81,74	77,44	73,98	80,71
− 1,05	+ 2,10	+ 7,04	+ 7,29	+ 4,11	− 1,53	− 3,81	− 4,56	− 2,75	− 0,44	− 2,44	− 3,98	±20,54 = 13,63
69,6	72,8	78,9	83,4	84,1	81,4	80,6	80,9	81,9	81,4	77,5	71,9	78,70
72,51	73,53	75,10	78,25	81,57	84,03	83,48	84,05	82,60	79,48	76,22	73,60	78,70
− 2,91	− 0,73	+ 3,80	+ 5,15	+ 2,53	− 2,63	− 2,88	− 3,15	− 0,70	+ 1,92	+ 1,28	− 1,70	±14,68 = 8,16
76,5	76,3	76,5	77,7	79,4	80,5	81,6	81,1	81,5	80,5	79,4	77,7	79,06
76,10	76,63	77,42	78,99	80,64	81,55	80,86	81,14	81,15	79,61	77,98	76,66	79,06
+ 0,40	− 0,33	− 0,92	− 1,29	− 1,24	− 1,05	+ 0,74	− 0,04	+ 0,35	+ 0,89	+ 1,42	+ 1,04	± 4,84 = 2,69
78,0	77,9	78,6	80,3	82,0	83,1	83,2	83,8	83,5	82,2	80,3	78,3	80,93
77,51	78,12	79,03	80,85	82,75	83,81	83,01	83,33	83,34	81,56	79,68	78,16	80,93
+ 0,49	− 0,22	− 0,43	− 0,55	− 0,75	− 0,71	+ 0,19	+ 0,47	+ 0,16	+ 0,64	+ 0,62	+ 0,14	± 2,71 = 1,51
70,0	75,7	82,1	87,1	88,8	82,0	77,2	77,2	76,3	76,0	71,8	69,0	77,77
69,69	71,12	73,28	77,59	82,08	84,59	82,69	83,45	83,48	79,26	74,81	71,21	77,77
+ 0,31	+ 4,58	+ 8,82	+ 9,51	+ 6,72	− 2,59	− 5,49	− 6,25	− 7,18	− 3,26	− 3,01	− 2,21	±29,94 = 16,63
75,8	78,8	83,3	86,3	87,8	87,7	85,2	85,3	84,7	83,3	79,3	75,2	82,73
76,65	77,72	79,35	82,59	85,98	87,86	86,43	87,00	87,03	83,85	80,51	77,79	82,73
− 0,85	+ 1,08	+ 3,95	+ 3,71	+ 1,82	− 0,16	− 1,23	− 1,70	− 2,33	− 0,55	− 1,21	− 2,59	±10,56 = 5,87
72,0	72,0	72,9	73,9	75,2	76,6	77,9	79,7	79,6	79,3	77,9	75,2	76,02
71,70	72,53	73,77	76,21	78,74	79,03	77,98	78,40	79,51	77,15	74,64	72,58	76,02
+ 0,30	− 0,53	− 0,87	− 2,31	− 3,54	− 2,43	− 0,08	+ 1,30	+ 0,09	+ 2,15	+ 3,26	+ 2,62	± 9,72 = 5,40
77,7	78,3	80,1	82,1	85,6	88,6	89,5	89,8	89,6	86,6	82,0	78,9	84,07
76,74	78,14	80,24	84,39	88,68	89,19	87,40	88,11	90,00	85,99	81,73	78,22	84,07
+ 0,96	+ 0,16	− 0,14	− 2,29	− 3,08	− 0,59	+ 2,10	+ 1,69	− 0,40	+ 0,61	+ 0,27	+ 0,68	± 6,47 = 3,59
76,9	78,2	80,6	83,1	84,0	82,1	80,2	80,0	79,8	79,6	78,8	77,0	80,03
77,17	77,72	78,54	80,16	81,83	82,03	81,33	81,61	82,34	80,78	79,12	77,75	80,03
− 0,27	+ 0,48	+ 2,06	+ 2,94	+ 2,17	+ 0,07	− 1,13	− 1,61	− 2,54	− 1,18	− 0,32	− 0,75	± 7,72 = 4,29
78,9	79,0	79,8	80,8	81,9	81,9	81,6	81,8	81,8	81,4	80,8	79,6	80,78
78,98	79,35	79,91	81,08	82,13	81,78	81,32	81,50	82,25	81,43	80,31	79,39	80,78
− 0,08	− 0,35	− 0,11	− 0,28	− 0,23	+ 0,12	+ 0,28	+ 0,30	− 0,45	− 0,03	+ 0,49	+ 0,21	± 1,40 = 0,78

No.	No. in Tab. XV	Parallel	PLACE	Latitude	Longitude	Height, merres	PERIOD		MV	Total displacem.	Temperature, observed and calcul.,
							years	years specified			
14	258	12° 30′ N	Kouka	12° 52′ N	13° 23′ E	280	2 1/2	1870—72	5,137 °F 2,85 °C	26	observed, Chall. Rep. calcul., normal the met. series
15	259	-	Red Sea	12° 40′ N	45° 0′ E	-	-	-	3,158 1,75	8	observed, Chall. Rep. calcul., normal the met. series
16	260	-	Aden	12° 45′ N	45° 3′ E	30	4 1/2	1880—84	3,853 2,14	12	observed, Chall. Rep. calcul., normal the met. series
17	261	-	Mangalore	12° 52′ N	74° 54′ E	16	15	1870—84	1,823 1,01	44	observed, Chall. Rep. calcul., normal the met. series
18	262	-	Bangalore	12° 59′ N	77° 38′ E	909	15	1870—84	3,060 1,70	30	observed, Chall. Rep. calcul., normal the met. series
19	263	-	Madras	13° 4′ N	80° 14′ E	7	15	1870—84	3,680 2,04	22	observed, Chall. Rep. calcul., normal the met. series
20	265	10° 0′ N	San José	9° 56′ N	84° 0′ W	1145	11	1868—78	1,417 0,79	48	observed, Chall. Rep. calcul., normal the met. series
21	266	-	Colon	9° 22′ N	79° 55′ W	50	5	1881—85	0,453 0,25	46	observed, Chall. Rep. calcul., normal the met. series
22	268	-	Caraccas	10° 30′ N	66° 55′ W	928	3	1868—70	1,548 0,86	14	observed, Chall. Rep. calcul., normal the met. series
23	269	-	St. Ann's Trinidad	10° 30′ N	61° 20′ W	40	18	1862—80	0,905 0,50	18	observed, Chall. Rep. calcul., normal the met. series
24	270	-	Cochin	9° 58′ N	76° 17′ E	4	15	1870—84	1,647 0,92	58	observed, Chall. Rep. calcul., normal the met. series
25	275	7° 30′ N	Kandy	7° 18′ N	80° 40′ E	517	15	1870—84	1,280 0,71	32	observed, Chall. Rep. calcul., normal the met. series
26	276	-	Batticalao	7° 43′ N	81° 44′ E	8	15	1870—84	2,287 1,27	26	observed, Chall. Rep. calcul., normal the met. series

	Jan.	Feb.	March	April	May	June	July	August	Septb.	Octb.	Novbr.	Decbr.	YEAR
	75,4	78,6	88,9	92,3	91,0	89,6	83,8	79,4	82,0	84,9	79,5	74,0	83,28°F
	73,96	75,90	78,80	84,47	90,27	88,46	86,06	87,02	40,88	86,64	80,83	76,08	83,28
	+ 1,44	+ 2,70	+10,10	+ 7,83	+ 0,73	+ 1,14	− 2,26	− 7,62	− 8,88	− 1,74	− 1,33	− 2,08	±23,94 = 13,30°C
	76,4	77,5	79,3	82,3	85,2	87,4	84,2	84,1	85,9	83,5	79,9	77,7	81,95
	76,22	77,41	79,19	82,68	86,25	85,13	83,66	84,25	86,62	84,01	80,45	77,52	81,95
	+ 0,18	+ 0,09	+ 0,11	− 0,38	− 1,05	+ 2,27	+ 0,54	− 0,15	− 0,72	− 0,51	− 0,55	+ 0,18	± 3,37 = 1,87
	75,2	75,9	78,4	81,7	85,2	86,5	84,9	84,8	86,2	81,8	77,5	75,6	81,14
	74,15	75,61	77,78	82,03	86,38	85,02	83,23	83,94	86,84	83,66	79,30	75,74	81,14
	+ 1,05	+ 0,29	+ 0,62	− 0,33	− 1,18	+ 1,48	+ 1,67	+ 0,86	− 0,64	− 1,86	− 1,80	− 0,14	± 5,97 = 3,32
	76,5	77,7	81,0	83,2	82,6	78,2	76,8	76,8	77,0	77,8	78,6	77,2	78,62
	75,31	76,00	77,03	79,04	81,10	80,46	79,61	79,95	81,32	79,81	77,75	76,06	78,62
	+ 1,19	+ 1,70	+ 3,97	+ 4,16	+ 1,50	− 2,26	− 2,81	− 3,15	− 4,32	− 2,01	+ 0,85	+ 1,14	±14,51 = 8,06
	67,3	71,8	76,8	80,1	78,5	74,2	72,2	72,1	71,9	71,8	69,7	67,3	72,81
	67,26	68,42	70,14	73,52	76,97	75,89	74,47	75,04	77,34	74,81	71,35	68,52	72,81
	+ 0,04	+ 3,38	+ 6,66	+ 6,58	+ 1,53	− 1,69	− 2,27	− 2,94	− 5,44	− 3,01	− 1,65	− 1,22	±18,19 = 10,11
	75,9	76,3	81,3	84,6	87,2	87,2	85,2	84,4	83,5	80,8	77,7	75,9	81,67
	74,99	76,39	78,46	82,52	86,68	85,38	83,66	84,35	87,11	84,08	79,92	76,51	81,67
	+ 0,91	− 0,09	+ 2,84	+ 2,08	+ 0,52	+ 1,82	+ 1,54	+ 0,05	− 3,61	− 3,28	− 2,22	− 0,61	± 9,76 = 5,42
	69,8	72,7	72,9	74,3	82,7	71,2	70,9	70,3	70,5	69,6	69,3	68,5	71,06
	68,35	68,97	69,90	71,71	73,50	72,19	71,44	71,74	72,95	72,40	70,55	69,01	71,06
	+ 1,45	+ 3,73	+ 3,00	+ 2,59	− 0,80	− 0,99	− 0,54	− 1,44	− 2,45	− 2,80	− 1,25	− 0,51	±10,77 = 5,98
	79,0	78,8	78,9	79,3	80,1	79,7	79,2	78,6	78,0	78,7	79,6	79,6	79,13
	78,26	78,46	78,76	79,34	79,91	79,49	79,25	79,35	79,73	79,56	78,97	78,48	79,13
	+ 0,74	− 0,34	+ 0,14	− 0,04	+ 0,19	+ 0,21	− 0,05	− 0,75	− 1,73	− 0,86	+ 0,63	+ 1,12	± 3,37 = 1,87
	68,5	68,9	69,3	72,5	73,9	73,0	72,0	72,6	72,5	71,4	71,2	68,9	71,23
	68,27	68,95	69,97	71,94	73,90	72,46	71,65	71,97	73,29	72,69	70,68	68,99	71,23
	+ 0,23	− 0,05	− 0,67	+ 0,56	0	+ 0,54	+ 0,35	+ 0,63	− 0,79	− 1,29	+ 0,52	− 0,09	± 2,83 = 1,57
	78,1	78,0	78,6	80,1	81,3	80,6	80,2	80,4	81,0	81,0	80,3	80,8	80,03
	78,30	78,70	79,29	80,44	81,59	80,75	80,28	80,46	81,23	80,88	79,71	78,72	80,03
	− 0,20	− 0,70	− 0,69	− 0,34	− 0,29	− 0,15	− 0,08	− 0,06	− 0,23	+ 0,12	+ 0,49	+ 2,08	± 2,69 = 1,49
	78,7	80,2	82,5	83,8	81,9	78,4	77,3	77,7	78,1	78,8	79,4	78,8	79,63
	76,48	77,21	78,29	80,38	82,47	80,94	80,08	80,42	81,82	81,18	79,04	77,25	79,63
	+ 2,22	+ 2,99	+ 4,21	+ 3,42	− 0,57	− 2,54	− 2,78	− 2,72	− 3,72	− 2,38	+ 0,36	+ 1,55	±14,75 = 8,20
	74,1	76,1	78,7	79,1	78,9	76,5	75,7	75,8	75,9	75,9	75,4	74,5	76,38
	73,73	74,43	75,46	77,45	78,56	77,13	76,33	76,65	77,96	78,21	76,18	74,47	76,38
	+ 0,37	+ 1,67	+ 3,24	+ 1,65	+ 0,34	− 0,63	− 0,63	− 0,85	− 2,06	− 2,31	− 0,78	+ 0,03	± 7,30 = 4,06
	78,0	79,0	81,2	83,6	84,6	85,1	84,7	83,9	83,4	81,9	79,6	78,2	81,93
	77,19	78,44	80,29	83,85	85,83	83,28	81,84	82,41	84,74	85,20	81,58	78,52	81,93
	+ 0,81	+ 0,56	+ 0,91	− 0,25	− 1,23	+ 1,82	+ 2,86	+ 1,49	− 1,34	− 3,30	− 1,98	− 0,32	± 8,45 = 4,70

No.	No. in Tab. XV	Parallel	PLACE	Latitude	Longitude	Height, metres	PERIOD		MV	Total displacem.	Temperature, observed and calcul.,
							years	years specified			
27	278	5° 0′ N	Cayenne	4° 56′ N	55° 39′ W	2	7	1846—52	0,942 °F 0,52 °C	24	observed, Chall. Rep. calcul., normal the met. series
28	280	-	Christiansborg	5° 24′ N	0° 10′ W	20	7 1/2	1829—40	1,947 1,08	50	observed, Chall. Rep. calcul., normal the met. series
29	281	-	Lado	5° 2′ N	31° 50′ E	465	4	1880—83	2,500 1,39	62	observed, Chall. Rep. calcul., normal the met. series
30	283	-	Penang	5° 24′ N	100° 20′ E	6	2	1885—86	1,377 0,77	48	observed, Chall. Rep. calcul., normal the met. series
31	284	2° 30′ N	Malacca	2° 10′ N	102° 14′ E	4	2	1885—86	0,467 0,26	42	observed, Chall. Rep. calcul., normal the met. series
32	286	Equat.	Quito	0° 14′ S	78° 45′ W	2851	1 1/2	1878—79	0,748 0,42	50	observed, Chall. Rep. calcul., normal the met. series
33	287	-	Antisana	0° 21′ S	78° 6′ W	4061	1	1845—46	1,583 0,88	42	observed, Chall. Rep. calcul., normal the met. series
34	288	-	St. Thomas	0° 20′ N	6° 43′ E	5	11	1870—82	1,050 0,58	46	observed, Chall. Rep. calcul., normal the met. series
35	289	-	Gabun	0° 25′ N	9° 35′ E	20	4	1880—85	1,527 0,85	40	observed, Chall. Rep. calcul., normal the met. series
36	291	2° 30′ S	Porto do Maranho	2° 30′ S	44° 0′ W	4	1 1/2	1886—87	0,637 0,35	44	observed, Chall. Rep. calcul., normal the met. series
37	292a	-	Palembang	2° 50′ S	104° 53′ E	6	6	various	0,437 0,24	28	observed, Chall. Rep. calcul., normal the met. series
38	295	5° 0′ S	Chinchoxo	5° 9′ S	12° 3′ E	12	6	1880—85	2,548 1,42	24	observed, Chall. Rep. calcul., normal the met. series
39	296	-	Rubaga	5° 24′ S	33° 33′ E	1300	3	1877—81	0,817 0,45	18	observed, Chall. Rep. calcul., normal the met. series

	Jan.	Feb.	March	April	May	June	July	August	Septb.	Octb.	Novbr.	Decbr.	YEAR
	79,1	79,0	79,4	80,0	79,9	79,9	80,5	81,4	81,8	82,0	81,4	79,1	80,29°F
	78,35	78,95	79,82	81,48	81,69	80,52	79,86	80,12	81,19	82,10	80,42	78,98	80,29
	+ 0,75	+ 0,05	− 0,42	− 1,48	− 1,79	− 0,62	+ 0,64	+ 1,28	+ 0,61	− 0,10	+ 0,98	+ 0,12	± 4,43 = 2,46°C
	80,6	81,7	82,8	83,1	82,6	79,2	77,0	75,6	77,9	80,6	81,9	81,1	80,34
	76,34	77,56	79,36	82,79	83,23	80,79	79,46	80,00	82,20	84,08	80,61	77,64	80,34
	+ 4,26	+ 4,14	+ 3,44	+ 0,31	− 0,63	− 1,59	− 2,46	− 4,40	− 4,30	− 3,48	+ 1,29	+ 3,46	±16,90 = 9,39
	82,4	85,5	85,1	81,3	79,3	77,5	76,8	76,6	77,0	78,4	79,2	80,6	79,98
	74,84	76,42	78,72	83,13	83,69	80,59	78,85	79,54	82,37	84,79	80,32	76,51	79,98
	+ 7,56	+ 9,08	+ 6,38	− 1,83	− 4,39	− 3,09	− 2,05	− 2,94	− 5,37	− 6,39	− 1,12	+ 4,09	±27,11 = 15,06
	82,6	83,5	85,1	85,0	83,6	82,8	82,6	81,4	80,0	80,9	80,6	80,9	82,42
	79,59	80,46	81,73	84,16	84,46	82,76	81,80	82,18	83,74	85,07	82,61	80,51	82,42
	+ 3,01	+ 3,04	+ 3,37	+ 0,84	− 0,86	+ 0,04	+ 0,80	− 0,78	− 3,74	− 4,17	− 2,01	+ 0,39	±11,49 = 6,38
	81,7	82,2	83,4	82,8	82,2	82,0	82,4	81,6	82,1	81,8	81,8	80,6	82,05
	81,19	81,50	81,96	82,82	82,56	81,97	81,64	81,77	82,31	83,09	82,27	81,52	82,05
	+ 0,51	+ 0,70	+ 1,44	− 0,02	− 0,36	+ 0,03	+ 0,76	− 0,17	− 0,21	− 1,29	− 0,47	− 0,92	± 3,44 = 1,91
	56,5	57,0	55,2	53,6	56,1	54,9	54,5	55,8	55,4	55,9	56,5	56,1	55,63
	54,48	55,01	55,77	57,20	56,19	55,21	54,67	54,88	55,77	57,06	56,29	55,04	55,63
	+ 2,02	+ 1,99	− 0,57	− 3,60	− 0,09	− 0,31	− 0,17	+ 0,92	− 0,37	− 1,16	+ 0,21	+ 1,06	± 6,20 = 3,44
	43,2	41,2	42,1	42,6	41,9	40,1	37,4	37,4	39,2	41,0	41,9	42,8	40,90
	38,47	39,58	41,19	44,22	42,08	40,01	38,87	39,32	41,20	43,92	42,29	39,65	40,90
	+ 4,73	+ 1,62	+ 0,91	− 1,62	− 0,18	+ 0,09	− 1,47	− 1,92	− 2,00	− 2,92	− 0,39	+ 3,15	±10,50 = 5,83
	78,4	78,8	78,8	78,6	78,2	76,6	75,0	75,2	77,0	77,4	77,6	78,4	77,50
	75,89	76,62	77,69	79,70	78,28	76,91	76,15	76,45	77,70	79,50	78,43	76,67	77,50
	+ 2,51	+ 2,18	+ 1,11	− 1,10	− 0,08	− 0,31	− 1,15	− 1,25	− 0,70	− 2,10	− 0,83	+ 1,73	± 7,53 = 4,18
	79,5	79,9	79,7	80,0	79,4	75,5	74,3	75,6	78,0	78,3	78,4	79,0	78,13
	75,78	76,86	78,41	81,33	79,27	77,27	76,17	76,61	78,42	81,04	79,48	76,92	78,13
	+ 3,72	+ 3,04	+ 1,29	− 1,33	+ 0,13	− 1,77	− 1,87	− 1,01	− 0,42	− 2,74	− 1,08	+ 2,08	±10,26 = 5,70
	82,0	81,8	81,6	80,1	81,2	81,1	81,3	82,2	83,0	83,0	82,6	82,0	81,83
	81,10	81,55	82,21	83,25	82,07	81,25	80,80	80,98	81,72	82,80	82,65	81,58	81,83
	+ 0,90	+ 0,25	− 0,61	− 3,15	− 0,87	− 0,15	+ 0,50	+ 1,22	+ 1,28	+ 0,20	− 0,05	+ 0,42	± 4,77 = 2,65
	79,7	80,0	80,7	80,7	81,1	80,3	80,0	79,9	81,0	80,8	80,6	79,8	80,38
	79,88	80,19	80,64	81,35	80,54	79,98	79,67	79,80	80,30	81,04	80,95	80,21	80,38
	− 0,18	− 0,19	+ 0,06	− 0,65	+ 0,56	+ 0,32	+ 0,33	+ 0,10	+ 0,70	− 0,24	− 0,35	− 0,41	± 2,07 = 1,15
	77,4	79,3	79,3	77,7	75,7	72,3	71,2	71,3	73,8	76,5	78,3	78,3	75,93
	74,11	75,95	78,61	80,76	76,05	72,81	71,04	71,74	74,66	78,96	80,41	76,07	75,93
	+ 3,29	+ 3,35	+ 0,69	− 3,06	− 0,35	− 0,51	+ 0,16	− 0,44	− 0,86	− 2,46	− 2,11	+ 2,23	± 9,72 = 5,40
	70,2	70,4	71,4	71,2	70,6	70,0	69,0	68,0	68,5	70,5	70,9	70,5	70,10
	69,52	70,11	70,96	71,65	70,14	69,10	68,53	68,76	69,69	71,07	71,54	70,14	70,10
	+ 0,68	+ 0,29	+ 0,44	− 0,45	+ 0,46	+ 0,90	+ 0,47	− 0,76	− 1,19	− 0,57	− 0,64	+ 0,36	± 3,60 = 2,00

No.	No. in Tab. XV	Parallel	PLACE	Latitude	Longitude	Height, metres	PERIOD		MV	Total displacem.	Temperature, observed and calcul.,
							years	years specified			
40	302	7° 30′ S	Ascension	7° 55′ S	14° 25′ W	16	2	1863—65	1,907 °F 1,06 °C	44	observed, Chall. Rep. calcul., normal the met. series
41	306	10° 0′ S	Somerset, Cape York	10° 44′ S	142° 36′ E	21	$2^1/_3$	1865—67	1,623 0,90	22	observed, Chall. Rep. calcul., normal the met. series
42	307	12° 30′ S	Callao	12° 4′ S	77° 14′ W	0	?	1857—70	3,827 2,13	16	observed, Chall. Rep. calcul., normal the met. series
43	308	-	St. Bento das Lagos	12° 37′ S	38° 40′ W	30	10	1872—81	2,613 1,45	14	observed, Chall. Rep. calcul., normal the met. series
44	309	-	Bahia	12° 58′ S	38° 30′ W	100	$3^1/_2$	1881—84	2,433 1,35	14	observed, Chall. Rep. calcul., normal the met, series
45	310	-	Port Darwin	12° 28′ S	130° 51′ E	21	5	1878—82	2,500 1,39	20	observed, Chall. Rep. calcul, normal the met. series
46	313	15° 0′ S	Sweers Island	15° 0′ S	136° 0′ E	10	$2^1/_2$	1868—71	4,637 2,58	14	observed, Chall. Rep. calcul., normal the met. series
47	314	17° 30′ S	Tahiti	17° 32′ S	149° 34′ W	0	5	1855—60	1,593 0,89	20	observed, Chall. Rep. calcul., normal the met. series
48	317	20° 0′ S	Iquique	20° 12′ S	70° 11′ W	10	3	1883—86	3,325 1,85	6	observed, Chall. Rep. calcul., normal the met. series
49	319	-	St. Denis, Reunion	20° 50′ S	55° 15′ E	16	3	1883—85	3,273 1,82	12	observed, Chall. Rep. calcul., normal the met. series
50	320	-	Mauritius, R. O.	20° 6′ S	57° 33′ E	54	15	1870—84	3,400 1,89	12	observed, Chall. Rep. calcul., normal the met. series
51	321	-	Rodriguez	19° 48′ S	63° 10′ E	3	11	1876—86	3,350 1,86	12	observed, Chall. Rep. calcul., normal the met. series
52	322	-	Cossack	20° 40′ S	117° 8′ E	6	$4^1/_2$	1881—85	6,937 3,85	10	observed, Chall. Rep. calcul., normal the met. series

Jan.	Feb.	March	April	May	June	July	August	Septb.	Octb.	Novbr.	Decbr.	YEAR
77,4	79,8	80,3	80,2	79,0	78,0	76,5	75,6	74,0	74,4	75,3	76,0	77,21 °F
76,76	77,94	79,64	79,72	76,75	74,73	73,63	74,06	75,88	78,59	80,79	78,02	77,21
+ 0,64	+ 1,86	+ 0,66	+ 0,48	+ 2,25	+ 3,27	+ 2,87	+ 1,54	− 1,88	− 4,19	− 5,49	− 2,02	± 13,57 = 7,54 °C
80,6	80,9	80,3	80,2	80,0	77,5	76,8	76,2	77,0	79,5	81,1	81,7	79,32
79,53	80,41	81,66	80,77	78,62	77,17	76,38	76,69	77,99	79,95	82,21	80,46	79,32
+ 1,07	+ 0,49	− 1,36	− 0,57	+ 1,38	+ 0,33	+ 0,42	− 0,49	− 0,99	− 0,45	− 1,11	+ 1,24	± 4,93 = 2,74
70,9	70,7	71,6	68,0	67,1	61,7	60,8	60,5	60,8	65,3	68,9	70,7	66,42
68,07	69,90	72,49	68,73	64,34	61,42	59,84	60,46	63,08	67,04	71,68	70,01	66,42
+ 2,83	+ 0,80	− 0,89	− 0,73	+ 2,76	+ 0,28	+ 0,96	+ 0,04	− 2,28	− 1,74	− 2,78	+ 0,69	± 8,36 = 4,64
79,7	80,1	79,7	78,3	75,7	73,8	72,3	72,5	74,0	76,6	78,8	79,7	76,77
77,90	79,14	80,91	78,34	75,35	73,35	72,28	72,70	74,49	77,19	80,36	79,22	76,77
+ 1,80	+ 0,96	− 1,21	− 0,04	+ 0,35	+ 0,45	+ 0,02	− 0,20	− 0,49	− 0,59	− 1,56	+ 0,48	± 4,06 = 2,26
82,8	82,5	82,4	80,2	78,4	76,1	74,8	75,2	77,0	79,1	79,9	82,0	79,20
80,25	81,41	83,06	80,67	77,88	76,02	75,02	75,41	77,08	79,59	82,55	81,48	79,20
+ 2,55	+ 1,09	− 0,66	− 0,47	+ 0,52	+ 0,08	− 0,22	− 0,21	− 0,08	− 0,49	− 2,65	+ 0,52	± 4,76 = 2,64
84,7	84,5	85,3	86,0	82,4	78,6	78,0	80,6	84,2	86,3	87,3	85,9	83,65
84,73	85,92	87,61	85,16	82,29	80,38	79,35	79,76	81,47	84,05	87,09	85,99	83,65
− 0,03	− 1,42	− 2,31	+ 0,84	+ 0,11	− 1,78	− 1,35	+ 0,84	+ 2,73	+ 2,25	+ 0,21	− 0,09	± 6,98 = 3,88
83,5	81,9	83,7	82,6	75,0	71,8	70,2	73,6	76,8	81,0	84,2	84,2	79,04
82,28	84,29	86,02	80,90	76,17	73,03	71,36	72,01	74,81	79,07	84,12	84,41	79,04
+ 1,22	− 2,39	− 2,32	+ 1,70	− 1,17	− 1,23	− 1,16	+ 1,59	+ 1,99	+ 1,93	+ 0,08	− 0,21	± 8,51 = 4,73
78,0	79,1	79,9	79,5	78,0	76,3	74,6	74,5	75,2	76,4	77,6	78,7	77,32
78,81	79,44	79,31	77,72	76,26	75,30	74,80	75,00	75,85	77,15	78,72	79,48	77,32
− 0,81	− 0,34	+ 0,59	+ 1,78	+ 1,74	+ 1,00	− 0,20	− 0,50	− 0,65	− 0,75	− 1,12	− 0,78	± 5,11 = 2,84
70,6	69,5	67,2	64,3	62,2	60,5	59,5	59,8	62,6	63,9	66,2	69,8	64,67
68,42	69,64	68,12	65,09	62,34	60,55	59,61	59,98	61,56	64,02	66,99	69,72	64,67
+ 2,18	− 0,14	− 0,92	− 0,79	− 0,14	− 0,05	− 0,11	− 0,18	+ 1,04	− 0,12	− 0,79	+ 0,08	± 3,30 = 1,83
78,4	79,1	78,6	77,1	73,4	70,0	70,0	69,7	71,2	73,1	75,7	77,8	74,51
78,21	79,41	77,90	74,92	72,21	70,46	69,53	69,90	71,45	73,87	76,79	79,48	74,51
+ 0,19	− 0,31	+ 0,70	+ 2,18	+ 1,19	− 0,46	+ 0,47	− 0,20	− 0,25	− 0,77	− 1,09	− 1,68	± 4,73 = 2,63
79,0	78,7	78,0	76,7	73,4	70,4	68,9	69,1	70,3	72,4	75,3	77,6	74,15
77,99	79,24	77,67	74,57	71,76	69,94	68,98	69,36	70,97	73,48	76,52	79,31	74,15
+ 1,01	− 0,54	+ 0,33	+ 2,13	+ 1,64	+ 0,46	− 0,08	− 0,26	− 0,67	− 1,08	− 1,22	− 1,71	± 5,57 = 3,10
80,9	80,7	80,3	78,9	75,5	72,4	71,1	70,9	72,6	74,3	76,6	79,6	76,15
79,93	81,16	79,62	76,57	73,80	72,00	71,06	71,43	73,02	75,49	78,48	81,24	76,15
+ 0,97	− 0,46	+ 0,68	+ 2,33	+ 1,70	+ 0,40	+ 0,04	− 0,53	− 0,42	− 1,19	− 1,88	− 1,64	± 6,12 = 3,40
88,5	89,6	85,0	78,5	74,8	66,0	65,6	70,0	75,0	79,8	82,6	87,6	78,58
86,41	88,96	85,77	79,45	73,71	69,99	68,03	68,80	72,10	77,22	83,41	89,11	78,58
+ 2,09	+ 0,64	− 0,77	− 0,95	+ 1,09	− 3,99	− 2,43	+ 1,20	+ 2,90	+ 2,58	− 0,81	− 1,51	± 10,50 = 5,83

No.	No. in Tab. XV	Parallel	PLACE	Latitude	Longitude	Height, merres	PERIOD		MV	Total displacem.	Temperature, observed and calcul.,
							years	years specified			
53	323	20° 0′ S	Ravenswood	20° 20′ S	146° 50′ E	183	2 1/2	1870—73	5,070 °F 2,82 °C	6	observed, Chall. Rep. calcul., normal the met. series
54	326	25° 6′ S	Salta	24° 46′ S	65° 24′ W	1230	7	1873—82	5,913 3,29	14	observed, Chall. Rep. calcul., normal the met. series
55	329	-	Assuncion	25° 16′ S	57° 40′ W	100	3	1855—57	6,703 3,72	12	observed, Chall. Rep. calcul., normal the met. series
56	333	-	Pretoria	25° 45′ S	28° 50′ E	1360	3 1/3	1875—78	4,020 2,23	6	observed, Chall. Rep. calcul., normal the met. series
57	334	-	Lorenzo Marques	25° 28′ S	32° 37′ E	5	1 3/4	1876—78	4,727 2,63	8	observed, Chall. Rep. calcul., normal the met. series

Jan.	Feb.	March	April	May	June	July	August	Septb.	Octb.	Novbr.	Decbr.	YEAR
79,0	80,8	78,3	75,6	69,6	65,7	64,6	66,9	70,5	73,8	77,5	80,2	73,54°F
79,26	81,12	78,80	74,17	69,98	67,26	65,83	66,39	68,80	72,54	77,07	81,24	73,54
− 0,26	− 0,32	− 0,50	+ 1,43	− 0,38	− 1,56	− 1,23	+ 0,51	+ 1,70	+ 1,26	+ 0,43	− 1,04	± 5,33 = 2,96°C
71,8	71,1	67,3	62,8	58,5	52,9	53,3	57,9	62,0	66,0	70,2	72,0	63,82
74,13	72,03	69,12	64,02	59,49	56,62	55,13	55,71	58,24	62,25	67,20	71,91	63,82
− 2,33	− 0,93	− 1,82	− 1,22	− 0,99	− 3,72	− 1,83	+ 2,19	+ 3,76	+ 3,75	+ 3,00	+ 0,09	±12,79 = 7,11
85,6	82,5	79,0	72,4	66,4	63,2	64,3	67,3	68,8	76,1	79,8	79,9	73,78
85,47	83,09	79,78	74,00	68,88	65,62	63,93	64,59	67,45	72,00	77,61	82,95	73,78
+ 0,13	− 0,59	− 0,78	− 1,60	− 2,48	− 2,42	+ 0,37	+ 2,71	+ 1,35	+ 4,10	+ 2,19	− 3,05	±10,85 = 6,03
73,6	73,4	70,0	67,1	64,9	59,7	58,8	59,9	66,9	68,0	70,0	70,0	66,86
73,87	72,44	70,46	66,99	63,92	61,96	60,95	61,35	63,06	65,80	69,16	72,36	66,86
− 0,27	+ 0,96	− 0,46	+ 0,11	+ 0,98	− 2,26	− 2,15	− 1,45	+ 3,84	+ 2,20	+ 0,84	− 2,36	± 8,93 = 4,96
80,5	81,6	79,3	75,4	72,5	66,0	66,0	68,9	69,6	72,3	76,0	79,2	73,94
82,18	80,50	78,17	74,10	70,48	68,18	67,00	67,46	69,48	72,68	76,64	80,40	73,94
− 1,68	+ 1,10	+ 1,13	+ 1,30	+ 2,02	− 2,18	− 1,00	+ 1,44	+ 0,12	− 0,38	− 0,64	− 1,20	± 7,11 = 3,95

TABLE XIII.

COMPARISON OF THE ACTUALLY OBSERVED AND THE CALCULATED NORMAL MONTHLY TEMPERATURE, THE CORRESPONDING METEOROLOGICAL SERIES AND THE TOTAL DISPLACEMENT OF THE MONTHS FOR VARIOUS PLACES, SITUATED IN THE TEMPERATE ZONE OF THE SOUTHERN HEMISPHERE.

The data in this table are all taken from the Challenger Reports, and the temperature given in degrees Fahrenheit and Centigrade.

CLASSIFICATION OF THE TERM $\Sigma\ (\pm \Delta m)$.

$\Sigma\ (\pm \Delta m) = 0$ to $2{,}00$ °C.

	MV	$\Sigma\ (\pm \Delta m)$
14. Valparaiso	1,90 °C	1,14 °C
15. East London...	2,07	1,44
18. Cape Town	2,63	1,09
19. Port Elisabeth .	2,25	1,52
21. Monte Video...	3,80	1,96
27. Napier	2,85	1,92
28. Valdivia	2,75	1,52

$= 2{,}00$ to $4{,}00$ °C.

	MV	$\Sigma\ (\pm \Delta m)$
2. Moreton Bay...	2,95 °C	2,49 °C
3 Copiapo	2,78	2,98
4. Brisbane	3,32	2,24
6. Geraldton	2,95	2,53
10. Springbok	3,49	3,07
12. Perth	3,69	2,64
13. Rio Grande do Sul	3,47	2,49
16. Santiago de Chili	3,57	2,97
17. Sydney	3,27	2,91
20. Buenos Ayres ..	4,30	2,85
22. Adelaide	3,82	3,02
23. Albany	2,38	2,82
24. Tandil.....	4,29	3,21
29. Wellington	2,65	2,36
30. Hobart Town ..	2,55	2,93
31. Christchurch...	3,31	2,07
32. Cape Pembroke.	1,94	3,08
33. Punta Arenas ..	2,84	2,31

$= 4{,}00$ to $6{,}00$ °C.

	MV	$\Sigma\ (\pm \Delta m)$
8. Goya	3,60 °C	4,03 °C
11. Bourke	5,65	5,10
25. Melbourne	3,09	4,52
26. Bahia Blanca ..	4,75	5,04
34. Ushaja	3,20	4,40

$\Sigma\ (\pm \Delta m) = 6{,}00$ to $9{,}00$ °C.

	MV	$\Sigma\ (\pm \Delta m)$
1. Tucuman.....	3,98 °C	6,84 °C
5. Thergomindal ..	5,66	6,93
7. Kimberley.....	4,70	7,49
9. Pietermaritzburg	2,75	6,08

No.	No. in Tab. XV	PLACE	Lati-tude	Longi-tude	Height, metres	PERIOD		MV	Total dis-placem.	Temperature, observed and calcul.,
						years	years specified			
1	327	Tucuman	26° 51′ S	65° 12′ W	464	7	1873—85	7,190°F 3,98°C	10	observed, Chall. Rep. calcul., normal the met. series
2	336	Moreton Bay	27° 1′	153° 28′ E	100	15	1870—84	5,320 2,95	2	observed, Chall. Rep. calcul., normal the met. series
3	339	Copiapo	27° 22′	70° 23′ W	395	5	1868—72	5,030 2,78	6	observed, Chall. Rep. calcul., normal the met. series
4	354	Brisbane	27° 28′	153° 6′ E	40	15	1870—84	5,983 3,32	4	observed, Chall. Rep. calcul., normal the met. series
5	351	Thergomindal	28° 0′	142° 30′ E	137	15	1870—84	10,153 5,66	6	observed, Chall. Rep. calcul., normal the met. series
6	350	Geraldton	28° 47′	114° 26′ E	2	6	1880—85	5,320 2,95	4	observed, Chall. Rep. calcul., normal the met. series
7	345	Kimberley	28° 48′	25° 2′ E	1238	15	1870—84	8,457 4,70	8	observed, Chall. Rep. calcul., normal the met. series
8	341	Goya	29° 0′	59° 15′ W	61	10	1876—86	6,467 3,60	8	observed, Chall. Rep. calcul., normal the met. series
9	348	Pietermaritzburg	29° 30′	30° 20′ E	638	10	1858—67	4,945 2,75	12	observed, Chall. Rep. calcul., normal the met. series
10	344	Springbok	29° 40′	17° 53′ E	976	4	1882—86	6,290 3,49	2	observed, Chall. Rep. calcul., normal the met. series
11	376	Bourke	30° 3′	145° 58′ E	139	15	1870—84	10,173 5,65	6	observed, Chall. Rep. calcul., normal the met. series
12	372	Perth	31° 37′	115° 52′ E	14	10	1876—85	6,647 3,69	6	observed, Chall. Rep. calcul., normal the met. series
13	363	Rio Grande do Sul	32° 0′ S	52° 15′ W	16	9	various	6,253 3,47	4	observed, Chall. Rep. calcul., normal the met. series

	Jan.	Feb.	March	April	May	June	July	August	Septb.	Octb.	Novbr.	Decbr.	YEAR
	77,7	75,2	72,5	67,1	59,4	54,5	54,0	58,8	64,6	69,1	73,6	76,1	66,88°F
	78,76	76,62	73,51	67,67	61,96	57,98	55,78	56,65	60,26	65,50	71,38	76,49	66,88
	− 1,06	− 1,42	− 1,01	− 0,57	− 2,56	− 3,48	− 1,78	+ 2,15	+ 4,34	+ 3,60	+ 2,22	− 0,39	±12,31 = 6,84°C
	78,0	77,5	75,6	71,8	66,9	62,7	60,0	63,1	66,7	69,7	73,4	76,7	70,18
	78,97	77,38	75,09	70,76	66,54	63,60	61,97	62,61	65,28	69,16	73,51	77,29	70,18
	− 0,97	+ 0,12	+ 0,51	+ 1,04	+ 0,36	− 0,90	− 1,97	+ 0,49	+ 1,42	+ 0,54	− 0,11	− 0,59	± 4,48 = 2,49
	68,7	66,7	64,2	59,0	55,2	51,6	50,7	53,6	56,5	59,5	62,2	65,7	59,47
	67,78	66,28	64,11	60,02	56,03	53,24	51,71	52,31	54,84	58,51	62,62	66,19	59,47
	+ 0,92	+ 0,42	+ 0,09	− 1,02	− 0,83	− 1,64	− 1,01	+ 1,29	+ 1,66	+ 0,99	− 0,42	− 0,49	± 5,37 = 2,98
	78,0	76,6	75,0	70,7	65,2	60,8	58,8	60,9	64,5	69,1	73,7	77,1	69,20
	79,08	77,30	74,72	69,86	65,10	61,80	59,96	60,69	63,69	68,06	72,95	77,19	69,20
	− 1,08	− 0,70	+ 0,28	+ 0,84	+ 0,10	− 1,00	− 1,16	+ 0,21	+ 0,81	+ 1,04	+ 0,75	− 0,09	± 4,03 = 2,24
	85,3	84,2	80,5	70,0	62,6	55,5	52,6	58,0	65,4	72,7	80,0	83,2	70,83
	87,60	84,58	80,19	71,94	63,88	58,27	55,16	56,38	61,48	68,89	77,19	84,40	70,83
	− 2,30	− 0,38	+ 0,31	− 1,94	− 1,28	− 2,77	− 2,56	+ 1,62	+ 3,92	+ 3,81	+ 2,81	− 1,20	±12,47 = 6,93
	73,2	74,6	71,3	66,9	62,6	58,9	57,5	58,1	60,5	63,6	68,3	70,8	65,53
	74,32	72,73	70,44	66,11	61,89	58,95	57,32	57,96	60,63	64,51	68,86	72,64	65,53
	− 1,12	+ 1,87	+ 0,86	+ 0,79	+ 0,71	− 0,05	+ 0,18	+ 0,14	− 0,13	− 0,91	− 0,56	− 1,84	± 4,55 = 2,53
	78,8	77,8	72,0	66,0	58,3	52,7	51,8	55,0	64,5	70,4	73,5	77,3	66,51
	80,48	77,96	74,31	67,44	60,72	56,04	53,46	54,48	58,73	64,89	71,81	77,81	66,51
	− 1,68	− 0,16	− 2,31	− 1,44	− 2,42	− 3,34	− 1,66	+ 0,52	+ 5,77	+ 5,51	+ 1,69	− 0,51	±13,49 = 7,49
	77,4	77,0	75,6	66,9	61,0	58,3	58,0	61,3	63,3	67,8	72,1	76,3	67,92
	78,60	76,68	73,88	68,63	63,49	59,92	57,94	58,72	61,97	66,68	71,97	76,56	67,92
	− 1,20	+ 0,32	+ 1,72	− 1,73	− 2,49	− 1,62	+ 0,06	+ 2,58	+ 1,33	+ 1,12	+ 0,13	− 0,26	± 7,26 = 4,03
	71,6	71,8	69,7	65,0	58,8	55,1	55,7	60,3	64,8	66,1	69,4	70,3	64,89
	73,06	71,59	69,45	65,43	61,50	58,77	57,26	57,85	60,34	63,94	67,99	71,50	64,89
	− 1,46	+ 0,21	+ 0,25	− 0,43	− 2,70	− 3,67	− 1,56	+ 2,45	+ 4,46	+ 2,16	+ 1,41	− 1,20	±10,94 = 6,08
	69,5	69,4	66,5	62,3	58,0	50,6	49,6	51,0	55,7	60,1	64,0	68,8	60,46
	70,85	68,98	66,26	61,15	56,15	52,68	50,75	51,51	54,67	59,26	64,40	68,86	60,46
	− 1,35	+ 0,42	+ 0,24	+ 1,15	+ 1,85	− 2,08	− 1,15	− 0,51	+ 1,03	+ 0,84	− 0,40	− 0,06	± 5,53 = 3,07
	84,2	82,6	77,5	68,5	58,4	54,1	51,5	56,0	61,8	70,0	75,8	82,3	68,56
	85,37	82,34	77,94	69,68	61,59	55,97	52,86	54,09	59,20	66,61	74,93	82,15	68,56
	− 1,17	+ 0,26	− 0,44	− 1,18	− 3,19	− 1,87	− 1,36	+ 1,91	+ 2,60	+ 3,39	+ 0,87	+ 0,15	± 9,18 = 5,10
	76,0	76,3	72,2	66,1	60,1	56,0	55,0	56,5	59,7	63,8	68,9	71,4	65,17
	76,15	74,17	71,30	65,90	60,62	56,94	54,91	55,71	59,05	63,90	69,33	74,05	65,17
	− 0,15	+ 2,13	+ 0,90	+ 0,20	− 0,52	− 0,94	+ 0,09	+ 0,79	+ 0,65	− 0,10	− 0,43	− 2,65	± 4,76 = 2,64
	75,9	74,8	73,0	67,3	60,8	57,3	56,3	58,8	61,0	64,5	69,9	72,8	66,03
	76,36	74,50	71,80	66,72	61,75	58,29	56,38	57,13	60,27	64,83	69,95	74,38	66,03
	− 0,46	+ 0,30	+ 1,20	+ 0,58	− 0,95	− 0,99	− 0,08	+ 1,67	+ 0,73	− 0,33	− 0,05	− 1,58	± 4,48 = 2,49

No.	No. in Tab. XV	PLACE	Lati-tude	Longi-tude	Height, metres	PERIOD		MV	Total dis-placem.	Temperature, observed and calcul.,
						years	years specified			
14	355	Valparaiso	33° 1′ S	71° 40′ W	46	10	1863—72	3,425 °F 1,90 °C	0	observed, Chall. Rep. calcul., normal the met. series
15	370	East London	33° 2′	27° 55′ E	12	15	1870—84	3,733 2,07	0	observed, Chall. Rep. calcul., normal the met. series
16	356	Santiago de Chili	33° 27′	70° 41′ W	46	10	1863—72	6,430 3,57	8	observed, Chall. Rep. calcul., normal the met. series
17	378	Sydney	33° 52′	151° 11′ E	47	15	1870—84	5,885 3,27	4	observed, Chall. Rep. calcul., normal the met. series
18	364	Cape Town	33° 56′	18° 27′ E	11	15	1870—84	4,730 2,63	0	observed, Chall. Rep. calcul., normal the met. series
19	369	Porth Elisabeth	33° 57′	25° 37′ E	55	15	1870—84	4,057 2,25	0	observed, Chall. Rep. calcul., normal the met. series
20	361	Buenos Ayres	34° 39′	58° 23′ W	4	21	1856—76	7,750 4,30	4	observed, Chall. Rep. calcul., normal the met. series
21	362	Monte Video	34° 54′	56° 13′ W	12	10	1843—52	6,833 3,80	0	observed, Chall. Rep. calcul., normal the met. series
22	374	Adelaide	34° 57′	138° 35′ E	43	15	1870—84	7,073 3,82	2	observed, Chall. Rep. calcul., normal the met. series
23	385	Albany	35° 2′	117° 54′ E	27	6	1880—85	4,280 2,38	6	observed, Chall. Rep. calcul., normal the met. series
24	384	Tandil	37° 17′	59° 8′ W	198	6	1876—82	7,713 4,29	4	observed, Chall. Rep. calcul., normal the met. series
25	390	Melbourne	37° 50′	144° 50′ E	28	15	1870—84	5,553 3,09	8	observed, Chall. Rep. calcul., normal the met. series
26	383	Bahia Blanca	38° 45′	62° 11′ W	15	14	1870—83	8,558 4,75	10	observed, Chall. Rep. calcul., normal the met. series

	Jan.	Feb.	March	April	May	June	July	August	Septb.	Octb.	Novbr.	Decbr.	YEAR
	63,0	63,0	60,5	57,4	55,1	53,3	52,8	52,8	54,1	57,1	59,3	62,7	57,59°F
	63,25	62,23	60,75	57,97	55,24	53,35	52,30	52,72	54,44	56,93	59,74	62,17	57,59
	− 0,25	+ 0,77	− 0,25	− 0,57	− 0,14	− 0,05	+ 0,50	+ 0,08	− 0,34	+ 0,17	− 0,44	+ 0,53	± 2,05 = 1,14°C
	70,5	70,0	68,7	66,2	62,6	59,9	58,4	59,9	62,2	64,0	66,8	69,6	64,90
	71,07	69,96	68,34	65,31	62,34	60,28	59,14	59,59	61,46	64,19	67,24	69,89	64,90
	− 0,57	+ 0,04	+ 0,36	+ 0,89	+ 0,26	− 0,38	− 0,74	+ 0,31	+ 0,74	− 0,19	− 0,44	− 0,29	± 2,60 = 1,44
	68,7	66,7	63,3	57,7	52,6	48,0	47,8	49,6	54,1	58,1	63,5	66,7	58,07
	68,69	66,78	64,00	58,78	53,67	50,11	48,14	48,92	52,15	56,84	62,10	66,66	58,07
	+ 0,01	− 0,08	− 0,70	− 1,08	− 1,07	− 2,11	− 0,34	+ 0,68	+ 1,95	+ 1,26	+ 1,40	+ 0,04	± 5,34 = 2,97
	71,5	71,0	69,2	64,7	58,7	54,0	52,5	55,5	58,8	63,0	66,4	70,3	62,97
	72,69	70,94	68,40	63,62	58,94	55,69	53,89	54,60	57,55	61,84	66,66	70,83	62,97
	− 1,19	+ 0,06	+ 0,80	+ 1,08	− 0,24	− 1,69	− 1,39	+ 0,90	+ 1,25	+ 1,16	− 0,26	− 0,53	± 5,25 = 2,91
	69,9	69,3	67,0	63,3	58,7	56,2	55,1	55,8	58,1	61,6	65,0	67,8	62,32
	70,13	68,73	66,68	62,84	59,08	56,47	55,02	55,59	57,97	61,41	65,28	68,64	62,32
	− 0,23	+ 0,57	+ 0,32	+ 0,46	− 0,38	− 0,27	+ 0,08	+ 0,21	+ 0,13	+ 0,19	− 0,28	− 0,84	± 1,96 = 1,09
	70,8	70,2	68,2	64,8	61,3	58,9	57,3	58,5	60,4	62,7	65,3	68,5	63,91
	70,61	69,40	67,65	64,36	61,13	58,89	57,65	58,14	60,18	63,13	66,45	69,33	63,91
	+ 0,19	+ 0,80	+ 0,55	+ 0,44	+ 0,17	+ 0,01	− 0,35	+ 0,36	+ 0,22	− 0,43	− 1,15	− 0,83	± 2,74 = 1,52
	75,6	74,3	70,3	62,8	56,5	52,4	50,0	53,6	57,0	62,3	68,6	72,8	63,02
	75,82	73,51	70,17	63,87	57,71	53,43	51,06	51,99	55,89	61,54	67,87	73,37	63,02
	− 0,22	+ 0,79	+ 0,13	− 1,07	− 1,21	− 1,03	− 1,06	+ 1,61	+ 1,11	+ 0,76	+ 0,73	− 0,57	± 5,13 = 2,85
	73,0	72,1	68,7	64,0	57,6	53,1	51,8	51,6	56,3	61,2	65,5	70,3	62,10
	73,39	71,35	68,40	62,85	57,42	53,64	51,55	52,38	55,81	60,79	66,38	71,23	62,10
	− 0,39	+ 0,75	+ 0,30	+ 1,15	+ 0,18	− 0,54	+ 0,25	− 0,78	+ 0,49	+ 0,41	− 0,88	− 0,93	± 3,53 = 1,96
	74,6	73,9	70,3	63,8	57,2	53,2	51,0	54,2	56,4	61,5	65,3	70,5	62,66
	74,34	72,24	69,18	63,44	57,82	53,91	51,74	52,60	56,15	61,31	67,09	72,11	62,66
	+ 0,26	+ 1,66	+ 1,12	+ 0,36	− 0,62	− 0,71	− 0,74	+ 1,60	+ 0,25	+ 0,19	− 1,79	− 1,61	± 5,44 = 3,02
	64,7	66,1	63,3	60,7	56,8	53,6	52,6	53,0	54,7	56,5	60,3	63,5	58,82
	65,89	64,62	62,77	59,29	55,89	53,52	52,21	52,73	54,88	58,00	61,50	64,54	58,82
	− 1,19	+ 1,48	+ 0,53	+ 1,41	+ 0,91	+ 0,08	+ 0,39	+ 0,27	− 0,18	− 1,50	− 1,20	− 1,04	± 5,07 = 2,82
	70,2	70,0	66,4	58,1	52,5	46,4	46,6	48,9	51,4	56,3	63,3	66,7	58,07
	70,81	68,51	65,18	58,92	52,79	48,52	46,16	47,10	50,97	56,59	62,90	68,38	58,07
	− 0,61	+ 1,49	+ 1,22	− 0,82	− 0,29	− 2,12	+ 0,44	+ 1,80	+ 0,43	− 0,29	+ 0,40	− 1,68	± 5,78 = 3,21
	65,9	66,0	63,5	58,6	53,1	49,6	47,2	50,4	53,2	56,5	59,5	63,2	57,23
	64,30	63,03	61,18	57,70	54,30	51,93	50,62	51,14	53,29	56,41	59,91	62,95	57,23
	+ 1,60	+ 2,97	+ 2,32	+ 0,90	− 1,20	− 2,33	− 3,42	− 0,74	− 0,09	+ 0,09	− 0,41	+ 0,25	± 8,13 = 4,52
	73,2	72,1	66,6	57,9	52,0	46,2	46,8	49,3	53,8	59,4	66,9	70,2	59,53
	73,67	71,12	67,42	60,47	53,67	48,94	46,32	47,35	51,65	57,89	64,89	70,96	59,53
	− 0,47	+ 0,98	− 0,82	− 2,57	− 1,67	− 2,74	+ 0,48	+ 1,95	+ 2,15	+ 1,51	+ 2,01	− 0,76	± 9,08 = 5,04

No.	No. in Tab. XV	PLACE	Lati-tude	Longi-tude	Height, metres	PERIOD		MV	Total dis-placem.	Temperature, observed and calcul.,
						years	years specified			
27	393	Napier	39° 29′ S	176° 55′ E	2	15	1870—84	5,127 °F 2,85 °C	0	observed, Chall. Rep. calcul., normal the met. series
28	380	Valdivia	39° 49′	73° 17′ W	13	15	18 ? —75	4,950 2,75	0	observed, Chall. Rep. calcul., normal the met. series
29	405	Wellington	41° 16′	174° 47′ E	43	15	1870—84	4,777 2,65	4	observed, Chall. Rep. calcul., normal the met. series
30	400	Hobart Town	42° 52′	147° 21′ E	11	15	1870—84	4,583 2,55	6	observed, Chall. Rep. calcul., normal the met. series
31	403	Christchurch	43° 32′	172° 39′ E	7	15	1870—84	5,960 3,31	2	observed, Chall. Rep. calcul., normal the met. series
32	399	Cape Pembroke	51° 41′	57° 47′ W	0	9	1859—68	3,483 1,94	10	observed, Chall. Rep. calcul., normal the met. series
33	395	Punta Arenas	53° 8′	70° 52′ W	10	8	1853—61	5,117 2,84	4	observed, Chall. Rep. calcul., normal the met. series
34	396	Ushaia	54° 53′ S	68° 10′ W	30	7 ½	1876—82	5,767 3,20	4	observed, Chall. Rep. calcul., normal the met. series

Jan.	Feb.	March	April	May	June	July	August	Septb.	Octb.	Novbr.	Decbr.	YEAR
66,5	66,2	64,4	60,2	56,0	52,3	50,1	51,2	54,6	57,8	61,4	64,8	58,79°F
67,26	65,73	63,52	59,35	55,28	52,44	50,88	51,49	54,07	57,81	62,00	65,64	58,79
− 0,76	+ 0,47	+ 0,88	+ 0,85	+ 0,72	− 0,14	− 0,78	− 0,29	+ 0,53	− 0,01	− 0,60	− 0,84	± 3,45 = 1,92°C
61,6	60,8	57,2	52,8	49,6	46,2	45,0	46,2	48,6	52,3	55,9	58,8	52,92
61,10	59,62	57,48	53,46	49,53	46,79	45,28	45,88	48,36	51,97	56,02	59,53	52,92
+ 0,50	+ 1,18	− 0,28	− 0,66	+ 0,07	− 0,59	− 0,28	+ 0,32	+ 0,24	+ 0,33	− 0,12	− 0,73	± 2,74 = 1,52
62,5	62,3	60,9	57,4	52,8	49,6	47,4	48,5	51,1	54,0	56,8	60,8	55,34
63,23	61,81	59,74	55,86	52,07	49,43	47,97	48,54	50,94	54,43	58,33	61,72	55,34
− 0,73	+ 0,49	+ 1,16	+ 1,54	+ 0,73	+ 0,17	− 0,57	− 0,04	+ 0,16	− 0,43	− 1,53	− 0,92	± 4,25 = 2,36
60,3	60,9	58,6	55,0	49,6	47,1	45,7	48,1	50,6	53,0	55,6	58,7	53,60
61,17	59,81	57,83	54,10	50,46	47,93	46,53	47,08	49,38	52,72	56,47	59,72	53,60
− 0,87	+ 1,09	+ 0,77	+ 0,90	− 0,86	− 0,83	− 0,83	+ 1,02	+ 1,22	+ 0,28	− 0,87	− 1,02	± 5,28 = 2,93
61,7	60,9	58,5	53,0	48,4	43,8	42,5	43,8	48,6	52,7	56,4	60,8	52,59
62,44	60,66	58,09	53,24	48,51	45,21	43,39	44,11	47,10	51,45	56,32	60,55	52,59
− 0,74	+ 0,24	+ 0,41	− 0,24	− 0,11	− 1,41	− 0,89	− 0,31	+ 1,50	+ 1,25	+ 0,08	+ 0,25	± 3,73 = 2,07
49,1	48,6	49,3	43,3	42,3	38,5	37,0	38,7	41,5	43,3	46,2	45,9	43,64
49,39	48,36	46,85	44,02	41,25	39,33	38,26	38,68	40,43	42,97	45,82	48,29	43,64
− 0,29	+ 0,24	+ 2,45	− 0,72	+ 1,05	− 0,83	− 1,26	+ 0,02	+ 1,07	+ 0,33	+ 0,38	− 2,39	± 5,54 = 3,08
51,5	50,4	47,1	42,0	38,8	36,8	34,6	36,0	39,7	43,9	46,8	49,6	43,10
51,55	50,03	47,82	43,66	39,60	36,77	35,20	35,82	38,39	42,12	46,31	49,94	43,10
− 0,05	+ 0,37	− 0,72	− 1,66	− 0,80	+ 0,03	− 0,60	+ 0,18	+ 1,31	+ 1,78	+ 0,49	− 0,34	± 4,16 = 2,31
52,2	49,6	45,5	42,0	38,5	33,3	30,8	32,4	39,4	42,0	47,6	48,3	41,80
51,33	49,61	47,12	42,43	37,85	34,66	32,90	33,59	36,49	40,70	45,41	49,51	41,80
+ 0,87	− 0,01	− 1,62	− 0,43	+ 0,65	− 1,36	− 2,10	− 1,19	+ 2,91	+ 1,30	+ 2,19	− 1,21	± 7,92 = 4,40

TABLE XIV.

GEOGRAPHICAL DISTRIBUTION OF THE TOTAL SUM OF THE METEOROLOGICAL SERIES = ($\Sigma \pm \Delta m$), AS DETERMINED BY THE DIFFERENCE OF THE OBSERVED AND THE NORMAL SERIES OF TEMPERATURE.

A. CLASSIFICATION OF THE GROUPS IN RESPECT TO CONTINENTS AND OCEANS.

	Total	I 0,00 to 2,00 °C	II 2,00 to 4,00 °C	III 4,00 to 6,00 °C	IV 6,00 to 9,00 °C	V 9,00 to 12,00 °C	VI over 12,00 °C
America	43	10	19	7	4	2	1
Atlantic Ocean	10	0	2	4	3	0	1
Europe	21	0	7	9	5	0	0
Africa	15	3	3	4	2	1	2
Asia.....	25	3	2	5	9	2	4
Australia.....	16	0	11	4	1	0	0
Indian & Pacific Ocean .	7	1	6	0	0	0	0
=	137	17	50	33	24	5	8

B. CLASSIFICATION OF THE GROUPS IN RESPECT TO ZONES.

Northern polar Zone ...	7	0	0	0	4	0	3
North. temperate Zone .	39	0	15	13	7	3	1
Tropical Zone.....	57	11	16	15	9	2	4
South. temperate Zone .	34	6	19	5	4	0	0
=	137	17	50	33	24	5	8

Obs. 1. The enumeration of the places refers to Tab. XI, XII and XIII respectively.

2. The letter "c" before a place indicates that the meteorological series of that place belong to the class of "continuous" series.

SITUATION		PLACE	I 0,00 to 2,00 °C	II 2,00 to 4,00 °C	III 4,00 to 6,00 °C	IV 6,00 to 9,00 °C	V 9,00 to 12,00 °C	IV over 12,00 °C
NORTH AMERICA								
Polar Regions		33. Fort Conger (81° 44′)	-	-	-	-	-	±16,80
Inland		38. Fort Franklin (65° 12′)	-	-	±5,15	-	-	-
		14. Moose Factory (51° 15′)	-	-	-	±6,83	-	-
		19. Quebec (46° 48′)	-	±2,70	-	-	-	-
		21. Chicago (41° 52′)	-	3,04	-	-	-	-
	c	27. St. Louis (38° 27′)	-	2,60	-	-	-	-
Atlantic Coast	c	23. New York (40° 43′)	-	3,89	-	-	-	-
Coast of Mexican Bay		32. New Orleans (29° 58′)	-	2,50	-	-	-	-
Pacific Coast		45. Sitka (57° 3′)	-	2,58	-	-	-	-
Coast of Alaska and	c	41. St. Michaels (63° 48′)	-	-	-	-	±10,03	-
Berings Sea		46. Berings Island (55° 12′)	-	-	-	-	9,05	-
CENTRAL-AMERICA AND THE WEST-INDIES		1. Havana (23° 8′)	±1,61	-	-	-	-	-
		6. Kingston (18° 1′)	-	2,69	-	-	-	-
	c	7. Christiansted (17° 45′)	1,51	-	-	-	-	-
		13. Barbadoes (13° 4′)	0,78	-	-	-	-	-
	c	20. San José (9° 56′)	-	-	5,98	-	-	-
		21. Colon (9° 22′)	1,87	-	-	-	-	-
	c	23. St. Ann's Trinidad (10° 30′)	1,49	-	-	-	-	-
SOUTH AMERICA								
Inland	c	54. Salta (24° 46′ S)	-	-	-	7,11	-	-
		55. Assuncion (25° 16′)	-	-	-	6,03	-	-
	c	1. Tucuman (26° 51′)	-	-	-	6,84	-	-
		8. Goya (29° 0′)	-	-	4,03	-	-	-
		24. Tandil (37° 17′)	-	3,21	-	-	-	-
Caraibian Coast		22. Caraccao (10° 30′)	1,57	-	-	-	-	-
Atlantic Coast		27. Cayenne (4° 56′)	-	2,46	-	-	-	-
		36. Porto do Maranho (2° 30′ S)	-	2,65	-	-	-	-
		43. St. Bento das Lagos (12° 37′)	-	2,26	-	-	-	-
		44. Bahia (12° 58′)	-	2,64	-	-	-	-
		13. Rio Grande do Sul (32° 0′)	-	2,49	-	-	-	-
		20. Buenos Ayres (34° 39′)	-	2,85	-	-	-	-
		21. Monte Video (34° 54′)	1,96	-	-	-	-	-
		26. Bahia Blanca (38° 45′)	-	-	5,04	-	-	-
Pacific Coast		32. Quito (0° 14′)	-	3,44	-	-	-	-
		33. Antisana (0° 21′)	-	-	5,83	-	-	-
		42. Callao (12° 4′)	-	-	4,64	-	-	-
		48. Iquique (20° 12′)	1,83	-	-	-	-	-
		3. Copiapo (27° 22′)	-	2,98	-	-	-	-
		14. Valparaiso (33° 1′)	1,14	-	-	-	-	-
	c	16. Santiago de Chili (33° 27′)	-	2,97	-	-	-	-
		28. Valdivia (39° 49′)	1,52	-	-	-	-	-
Falkland Isles and		32. Cape Pembroke (51° 41′)	-	3,08	-	-	-	-
Terra del Fuego		33. Punta Arenas (53° 8′)	-	2,31	-	-	-	-
		34. Ushaja (54° 53′)	-	-	4,40	-	-	-

SITUATION	PLACE	I 0,00 to 2,00 °C	II 2,00 to 4,00 °C	III 4,00 to 6,00 °C	IV 6,00 to 9,00 °C	V 9,00 to 12,00 °C	VI over 12,00 °C
ATLANTIC OCEAN							
West Coast of Greenland	c 1. Upernivik (72° 47′)	-	-	-	-	-	15,26
	35. Jacobshavn (69° 13′)	-	-	-	9,00	-	-
	39. Godthaab (64° 11′)	-	-	4,73	-	-	-
	42. Ivigtut (61° 12′)	-	-	4,03	-	-	-
	43. Julianehaab (60° 44′)	-	3,46	-	-	-	-
Iceland	40. Rejkiavik (64° 9′)	-	-	4,86	-	-	-
Færöe Islands	3. Thorshavn (62° 2′)	-	3,64	-	-	-	-
Southern Isles	c 30. Bermuda (32° 17′)	-	-	-	7,35	-	-
	c 10. Praya (14° 54′)	-	-	5,40	-	-	-
	c 40. Ascension (7° 55′ S)	-	-	-	7,54	-	-
PACIFIC OCEAN							
	c 47. Tahiti (17° 32′ S)	-	2,84	-	-	-	-
New Zealand	27. Napier (39° 29′)	1,92	-	-	-	-	-
	29. Wellington (41° 16′)	-	2,36	-	-	-	-
	31. Christchurch (43° 32′)	-	2,07	-	-	-	-
INDIAN OCEAN	49. St. Denis, Reunion (20° 50′ S)	-	2,63	-	-	-	-
	50. Mauritius (20° 6′ S)	-	3,10	-	-	-	-
	51. Rodriguez (19° 48′ S)	-	3,40	-	-	-	-
EUROPE							
Polar Regions	c 34. Vardö (70° 22′)	-	-	-	±6,58	-	-
	36. Kola (68° 53′)	-	-	-	7,30	-	-
Northern Europe	4. St. Petersburg (59° 56′)	-	-	±5,02	-	-	-
	5. Christiania (59° 55′)	-	-	4,99	-	-	-
	6. Stockholm (59° 20′)	-	-	-	6,24	-	-
	9. Copenhagen (55° 41′)	-	±3,92	-	-	-	-
	10. Hamburg (53° 33′)	-	3,26	-	-	-	-
Western Europe	12. Valentia (51° 55′)	-	3,20	-	-	-	-
	13. London-Greenw. (51° 30′)	-	3,66	-	-	-	-
	16. Paris (48° 50′)	-	-	4,60	-	-	-
	24. Madrid (40° 22′)	-	-	-	8,18	-	-
	26. Lisbon (38° 42′)	-	-	4,70	-	-	-
Middle Europe	11. Berlin (52° 30′)	-	3,20	-	-	-	-
	17. Vienna (48° 14′)	-	3,93	-	-	-	-
	18. Buda-Pesth (47° 30′)	-	-	4,37	-	-	-
Eastern Europe	8. Moscow (55° 50′)	-	-	5,84	-	-	-
	c 22. Constantinople (41° 0′)	-	-	-	6,13	-	-
Mediteranean Zone	29. Gibraltar (36° 8′)	-	-	4,82	-	-	-
	20. Rome (41° 54′)	-	3,82	-	-	-	-
	c 28. Athens (37° 58′)	-	-	4,03	-	-	-
	c 31. Jerusalem (31° 47′)	-	-	5,42	-	-	-

SITUATION	PLACE	I 0,00 to 2,00 °C	II 2,00 to 4,00 °C	III 4,00 to 6,00 °C	IV 6,00 to 9,00 °C	V 9,00 to 12,00 °C	VI over 12,00 °C
AFRICA							
Inland	c 14. Kouka (12° 52′ N)	-	-	-	-	-	13,30
	c 29. Lado (5° 2′ N)	-	-	-	-	-	15,06
	39. Rubaga (5° 24′ S)	2,00	-	-	-	-	-
	56. Pretoria (25° 45′ S)	-	-	4,96	-	-	-
	c 7. Kimberley (28° 48′ S)	-	-	-	7,49	-	-
	10. Springbok (29° 40′ S)	-	3,07	-	-	-	-
West Coast	c 28. Christiansborg (5° 24′ N)	-	-	-	-	9,39	-
	35. Gabun (0° 25′ N)	-	-	5,70	-	-	-
	c 34. St. Thomas 0° 20′ N)	-	-	4,18	-	-	-
	38. Chinchoxo (5° 9′ S)	-	-	5,40	-	-	-
East Coast	57. Lorenço Marquez (25° 28′ S)	-	3,95	-	-	-	-
	9. Pietermaritzburg (29° 30′ S)	-	-	-	6,08	-	-
South Coast	15. East London (33° 2′ S)	-	2,60	-	-	-	-
	18. Cape Town (33° 56′ S)	1,96	-	-	-	-	-
	19. Port Elisabeth (33° 57′ S)	1,52	-	-	-	-	-
ASIA							
Polar Regions	c 37. Werchojansk (67° 34′)	-	-	-	-	-	18,05
	2. Obdorsk (66° 31′)	-	-	-	8,55	-	-
Siberia, Inland	c 44. Olekminsk (60° 22′)	-	-	-	-	-	18,05
	7. Tomsk (56° 30′)	-	-	-	8,45	-	-
	15. Semipolatinsk (50° 24′)	-	-	-	8,58	-	-
	25. Samarkand (39° 39′)	-	-	-	-	9,38	-
India, Inland	c 8. Secunderabad (17° 27′ N)	-	-	-	-	-	16,63
	c 18. Bangalore (12° 59′)	-	-	-	-	10,11	-
Coast of Arab. Sea, West	3. Mascat (23° 38′)	-	-	-	7,36	-	-
East	c 17. Mangalore (12° 52′)	-	-	-	8,06	-	-
	c 24. Cochin (9° 58′)	-	-	-	8,20	-	-
Coast of Bengal Bay, West	c 4. Cuttack (20° 9′)	-	-	-	-	-	13,63
	c 9. Visagapatam (17° 42′)	-	-	5,87	-	-	-
	19. Madras (13° 4′)	-	-	5,42	-	-	-
East	5. Akyab (20° 28′)	-	-	-	8,16	-	-
Ceylon	c 25. Kandy (7° 18′)	-	-	4,06	-	-	-
	26. Batticalao (7° 43′)	-	-	4,70	-	-	-
Malacca Peninsula and East India Archipelago	c 12. Manila (14° 35′)	-	-	4,29	-	-	-
	30. Penang (5° 24′)	-	-	-	6,38	-	-
	31. Malacca (2° 10′)	1,91	-	-	-	-	-
	37. Palembang (2° 50′ S)	1,15	-	-	-	-	-
Red Sea and Arabia	c 2. Red Sea (23°/37° E)	-	-	-	6,52	-	-
	11. Red Sea (15°/42° E)	-	3,59	-	-	-	-
	15. Red Sea (12° 40′/45° E)	1,87	-	-	-	-	-
	16. Aden (12° 45′/45° 3′ E)	-	3,32	-	-	-	-

SITUATION	PLACE	I 0,00 to 2,00 °C	II 2,00 to 4,00 °C	III 4,00 to 6,00 °C	IV 6,00 to 9,00 °C	V 9,00 to 12,00 °C	VI over 12,00 °C
AUSTRALIA AND TASMANIA							
Inland	5. Thergomindal (28° 0′)	-	-	-	6,93	-	-
	11. Bourke (30° 3′)	-	-	5,10	-	-	-
North Coast	41. Somerset, Cape York (10° 44′)	-	2,74	-	-	-	-
	45. Port Darwin (12° 28′)	-	3,88	-	-	-	-
	46. Sweers Island (15° 0′)	-	-	4,73	-	-	-
	52. Cossack (20° 40′)	-	-	5,83	-	-	-
West Coast	6. Geraldton (28° 47′)	-	2,53	-	-	-	-
	12. Perth (31° 37′)	-	2,64	-	-	-	-
East Coast	53. Ravenswood (20° 20′)	-	2,96	-	-	-	-
	2. Moreton Bay (27° 1′)	-	2,49	-	-	-	-
	4. Brisbane (27° 28′)	-	2,24	-	-	-	-
	17. Sydney (33° 52′)	-	2,91	-	-	-	-
South Coast	22. Adelaide (34° 57′)	-	3,02	-	-	-	-
	c 23. Albany (35° 2′)	-	2,82	-	-	-	-
	25. Melbourne (37° 50′)	-	-	4,52	-	-	-
Tasmania	30. Hobarttown (42° 52′)	-	2,93	-	-	-	-

TABLE XV.

GENERAL PROSPECT AND COMPARISON OF THE OBSERVED AND THE NORMAL MOVEMENT OF TEMPERATURE, AS DETERMINED FOR 407 PLACES, SITUATED IN THE POLAR, TEMPERATE AND TROPICAL ZONE OF THE NORTHERN AND SOUTHERN HEMISPHERE.

The data in this table are all taken from the Challenger Reports, and the temperature given in degrees Centigrade.

No.	PLACE	Lati-tude	Longi-tude	Height, metres	PERIOD: number of years	PERIOD: the years	MV °C	Total displacement	January	February	March	April	May	June	July	August	Septemb.	Octob.	Novbr.	Decbr.	$\Sigma (\pm \Delta m)$
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
NORMAL ORDRE OF THE MONTHS IN THE NORTHERN TEMPERATE AND POLAR ZONES					-	-	-	-	12	11	9	7	5	3	1	2	4	6	8	10	
ARCTIC REGIONS, NORTH OF 66° 33′																					
1	Gulf of Boothia	70° 6′	91° 45′ W	0	2½	1829-32	13,06	6	10	12	11	7	5	3	1	2	4	6	8	9	
2	Fort Hope	66° 32′	86° 56′ W	3	2	various	13,21	2	11	12	9	7	5	3	1	2	4	6	8	10	
3	Fort Conger	81° 44′	64° 45′ W	0	2	1881-83	14,21	6	11	12	8	7	4	3	1	2	5	6	9	10	±16,80°C
4	Upernivik	72° 47′	55° 53′ W	12	11	1874-84	8,68	6	11	12	10	8	5	3	1	2	4	6	7	9	±15,26
5	Jacobshavn	69° 13′	50° 55′ W	13	11	1874-84	7,61	4	11	12	10	7	5	3	1	2	4	6	8	9	± 9,00
6	Grimsey	66° 34′	18° 3′ W	3	15	1870-84	3,53	12	11	12	10	8	6	4	2	1	3	5	7	9	
7	Bodö	67° 17′	14° 24′ E	5	15	1870-84	5,05	2	11	12	9	7	5	3	1	2	4	6	8	10	
8	Gjæsvær	71° 7′	25° 22′ E	7	15	1870-84	4,68	6	11	12	10	7	6	3	1	2	4	5	8	9	
9	Vardö	70° 22′	31° 7′ E	10	15	1870-84	4,71	10	10	12	9	7	6	4	2	1	3	5	8	11	± 6,58
10	Kola	68° 53′	33° 1′ E	10	15	1870-84	7,80	4	11	12	8	7	5	3	1	2	4	6	9	10	± 7,30
11	Obdorsk	66° 31′	66° 35′ E	24	15	1870-84	11,40	0	12	11	9	7	5	3	1	2	4	6	8	10	± 8,55
12	Sagastyr	73° 23′	126° 35′ E	5	2	1882-84	14,63	6	11	12	10	7	5	4	1	2	3	6	8	9	
13	Werchojansk	67° 34′	133° 51′ E	140	5	various	21,61	6	12	10	8	6	5	3	1	2	4	7	9	11	±18,05
14	Ssredne-Kolymsk	67° 10′	157° 10′ E	30	4½	various	15,19	2	12	11	9	6	5	3	1	2	4	7	8	10	
SECTION ARCTIC CIRCLE TO c. 60° 0′ N																					
15	Ikogmut	61° 47′	161° 14′ W	23	2½	various	9,83	6	11	12	10	7	5	2	1	3	4	6	8	9	
16	St. Michaels	63° 48′	161° 0′ W	10	14	1872-86	9,20	4	11	12	10	7	5	3	1	2	4	6	8	9	±10,03°C
17	Fort Franklin	65° 12′	123° 13′ W	152	1¾	?	13,55	0	12	11	9	7	5	3	1	2	4	6	8	10	± 5,15
18	Winter Island	66° 11′	83° 10′ W	0	1	1821-22	10,63	6	11	12	9	8	5	3	2	1	4	6	7	10	
19	Sukkertoppen	65° 24′	53° 14′ W	0	11	1874-84	6,27	4	11	12	10	7	5	3	1	2	4	6	8	9	
20	Godthaab	64° 11′	51° 45′ W	11	11	1874-84	5,19	4	11	12	10	7	5	3	1	2	4	6	8	9	± 4,73
21	Ivigtut	61° 12′	48° 11′ W	5	11	1874-84	5,42	2	11	12	9	7	5	3	1	2	4	6	8	10	± 4,03
22	Julianehaab	60° 44′	45° 59′ W	8	11	1874-84	5,18	6	11	12	10	7	5	3	2	1	4	6	8	9	± 3,46
23	Stykkisholm	65° 5′	22° 46′ W	11	15	1870-84	4,05	2	12	11	10	7	5	3	1	2	4	6	8	9	
24	Rejkjavik	64° 9′	22° 0′ W	7	15	1870-84	4,39	4	12	10	11	7	5	3	1	2	4	6	8	9	± 4,86
25	Berufjord	64° 40′	14° 15′ W	18	15	1870-84	3,54	6	11	12	10	8	5	3	1	2	4	6	7	9	
26	Thorshavn	62° 2′	6° 43′ W	4	15	1870-84	2,64	6	11	9	10	7	5	3	2	1	4	6	8	12	± 3,64
27	North Unst	60° 51′	0° 53′ W	70	15	1870-84	2,54	12	10	11	12	7	6	4	2	1	3	5	8	9	
28	Bergen	60° 24′	5° 20′ E	18	15	1870-84	4,73	2	11	12	9	7	5	3	1	2	4	6	8	10	
29	Christiansund	63° 7′	7° 45′ E	16	15	1870-84	4,25	2	11	12	9	7	5	3	1	2	4	6	8	10	
30	Östersund	63° 11′	14° 38′ E	296	15	1870-84	7,41	2	11	12	9	7	5	3	1	2	4	6	8	10	
31	Hernösand	62° 38′	17° 58′ E	14	15	1870-84	7,11	4	10	12	9	7	5	3	1	2	4	6	8	11	
32	Åbo	60° 27′	21° 52′ E	15	15	1870-84	7,50	2	11	12	9	7	5	3	1	2	4	6	8	10	
33	Haparanda	65° 50′	23° 29′ E	10	15	1870-84	8,60	4	10	12	9	7	5	3	1	2	4	6	8	11	
34	Kuopia	62° 54′	27° 20′ E	88	15	1870-84	8,56	4	11	12	9	7	5	2	1	3	4	6	8	10	
35	Archangel	64° 33′	40° 32′ E	5	15	1870-84	9,38	0	12	11	9	7	5	3	1	2	4	6	8	10	
36	Ust-Syssolsk	61° 40′	50° 51′ E	100	51	1817-67	9,48	2	12	10	9	7	5	3	1	2	4	6	8	11	
37	Beresow	63° 56′	65° 4′ E	36	15	1870-81	11,42	4	12	10	8	7	5	3	1	2	4	6	9	11	
38	Turuchansk	65° 55′	87° 38′ E	19	10½	1877-87	12,53	4	12	10	8	7	5	3	1	2	4	6	9	11	
39	Olekminsk	60° 22′	120° 26′ E	122	15	1870-84	17,05	6	12	10	8	7	5	2	1	3	4	6	9	11	±18,05
40	Jakutsk	62° 2′	129° 45′ E	102	35	1829-73	19,72	4	12	10	8	7	5	3	1	2	4	6	9	11	

No.	PLACE	Lati-tude	Longi-tude	Height, metres	PERIOD		MV	Total displacement	January	February	March	April	May	June	July	August	Septemb.	Octob.	Novbr.	Decbr.	$\Sigma (\pm \Delta m)$
					number of years	the years	°C														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
NORMAL ORDER OF THE MONTHS IN THE NORTHERN TEMPERATE AND POLAR ZONES					-	-	-	-	12	11	9	7	5	3	1	2	4	6	8	10	
SECTION 60° TO c. 55° 0′ N																					
41	St. Paul's Island	57° 7′	170° 18′ W	18	6	1869-76	4,00	14	10	11	12	8	6	4	2	1	3	5	7	9	
42	Sitka	57° 3′	135° 19′ W	5	43	1832-76	4,41	2	12	11	9	7	5	3	2	1	4	6	8	10	±2,58 °C
43	York Factory	57° 2′	92° 28′ W	17	10	1875-84	14,30	0	12	11	9	7	5	3	1	2	4	6	8	10	
44	North Atlantic	57° 30′	47° 30′ W	0	$5^2/_3$	-	4,57	0	12	11	9	7	5	3	1	2	4	6	8	10	
45	North Atlantic	57° 30′	27° 30′ W	0	$5^2/_3$	-	2,86	10	11	12	10	7	6	4	2	1	3	5	8	9	
46	North Atlantic	57° 30′	12° 30′ W	0	$5^2/_3$	-	2,69	2	12	11	9	7	5	4	1	2	3	6	8	10	
47	Stornoway	58° 13′	6° 23′ W	21	15	1870-84	3,01	4	11	10	9	7	5	3	1	2	4	6	8	12	
48	Christiania	59° 55′	10° 43′ E	25	15	1870-84	7,18	2	11	12	9	7	5	3	1	2	4	6	8	10	±4,99
49	Copenhagen	55° 41′	12° 36′ E	14	15	1870-84	5,73	2	11	12	9	7	5	3	1	2	4	6	8	10	±3,92
50	Stockholm	59° 20′	18° 4′ E	44	15	1870-84	6,48	2	11	12	9	7	5	3	1	2	4	6	8	10	±6,24
51	St. Petersburg	59° 56′	30° 16′ E	6	15	1870-84	8,86	2	11	12	9	7	5	3	1	2	4	6	8	10	±5,02
52	Moscow	55° 50′	37° 33′ E	155	15	1870-84	9,26	4	12	11	9	7	4	2	1	3	5	6	8	10	±5,84
53	Wjätka	58° 36′	49° 41′ E	177	15	1870-84	10,12	4	12	11	9	7	4	2	1	3	5	6	8	10	
54	Tobolsk	58° 12′	68° 16′ E	108	15	1870-84	11,68	6	12	10	8	7	4	3	1	2	5	6	9	11	
55	Tomsk	56° 30′	84° 58′ E	77	15	1870-84	12,17	4	12	10	8	7	5	3	1	2	4	6	9	11	±8,45
56	Enisseisk	58° 27′	92° 6′ E	84	15	1870-84	12,81	4	12	10	8	7	5	3	1	2	4	6	9	11	
57	Ochotsk	59° 20′	142° 40′ E	4	$9^1/_2$	1843-52	12,30	8	12	10	8	7	5	4	2	1	3	6	9	11	
58	Bering Island	55° 12′	165° 55′ E	6	4	1882-86	4,19	14	12	9	11	8	6	4	3	1	2	5	7	10	±9,05
SECTION 55° TO c. 50° 0′ N																					
59	Ilinlink Harbour	53° 52′	166° 31′ W	5	9	1827-73	3,81	2	12	11	9	7	5	3	2	1	4	6	8	10	
60	Fort Simpson	54° 37′	130° 23′ W	0	$2^1/_2$	1886-89	4,00	4	12	11	9	7	5	4	2	1	3	6	8	10	
61	Medicine Hat	50° 1′	110° 37′ W	651	$5^1/_2$	1883-88	10,61	2	12	11	9	6	5	3	1	2	4	7	8	10	
62	Moose Factory	51° 15′	80° 45′ W	10	24	1857-80	11,45	0	12	11	9	7	5	3	1	2	4	6	8	10	±6,83 °C
63	Belle Isle	51° 53′	55° 22′ W	122	$2^1/_3$	1882-84	7,29	8	12	10	9	7	6	4	2	1	3	5	8	11	
64	North Atlantic	52° 30′	47° 30′ W	0	$5^2/_3$	-	4,46	10	11	12	10	7	6	4	2	1	3	5	8	9	
65	North Atlantic	52° 30′	27° 30′ W	0	$5^2/_3$	-	2,39	10	11	12	10	7	6	4	2	1	3	5	8	9	
66	North Atlantic	52° 30′	12° 30′ W	0	$5^2/_3$	-	2,55	6	12	11	9	7	6	4	2	1	3	5	8	10	
67	Valentia	51° 55′	10° 18′ W	7	15	1870-84	2,63	6	12	10	9	7	5	4	2	1	3	6	8	11	±3,20
68	Dublin	53° 22′	6° 21′ W	48	15	1870-84	3,43	2	12	11	9	7	5	3	2	1	4	6	8	10	
69	London-Greenwich	51° 30′	0° 0′	48	15	1870-84	4,54	2	12	10	9	7	5	3	1	2	4	6	8	11	±3,66
70	Amsterdam	52° 22′	4° 53′ E	9	15	1870-84	4,94	0	12	11	9	7	5	3	1	2	4	6	8	10	
71	Hamburg	53° 33′	9° 59′ E	26	15	1870-84	5,50	2	12	10	9	7	5	3	1	2	4	6	8	11	±3,26
72	Berlin	52° 30′	13° 23′ E	41	15	1870-84	6,09	2	12	10	9	7	5	3	1	2	4	6	8	11	±3,20
73	Warsaw	52° 13′	21° 2′ E	120	15	1870-84	7,21	2	12	11	9	7	5	2	1	3	4	6	8	10	
74	Kursk	51° 45′	36° 0′ E	210	28	1833-68	9,25	0	12	11	9	7	5	3	1	2	4	6	8	10	
75	Orenburg	51° 46′	55° 6′ E	91	15	1870-84	11,89	8	11	12	9	6	4	2	1	3	5	7	8	10	
76	Omsk	54° 58′	73° 20′ E	79	15	1870-84	12,43	4	12	10	8	7	5	3	1	2	4	6	9	11	
77	Barnaul	53° 20′	83° 47′ E	140	15	1870-84	12,25	0	12	11	9	7	5	3	1	2	4	6	8	10	
78	Irkutsk	52° 16′	104° 16′ E	468	15	1870-84	12,70	10	12	10	8	6	4	2	1	3	5	7	9	11	
79	Kjachta	50° 20′	106° 35′ E	718	15	1870-84	13,62	10	12	10	8	6	4	2	1	3	5	7	9	11	
80	Nicolajewsk	53° 8′	140° 45′ E	18	15	1870-84	12,92	2	12	10	9	7	5	3	1	2	4	6	8	11	
81	Duc	50° 50′	142° 7′ E	100	15	1870-84	10,11	4	12	11	9	7	5	4	2	1	3	6	8	10	
82	Petropaulowsk	53° 0′	158° 39′ E	15	7	1828-53	7,24	2	11	12	9	7	5	3	1	2	4	6	8	10	

No.	PLACE	Lati-tude	Longi-tude	Height, metres	PERIOD		MV	Total displacement	January	February	March	April	May	June	July	August	Septemb.	Octob.	Novbr.	Decbr.	$\Sigma (\pm \Delta m)$
					number of years	the years	°C														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
NORMAL ORDER OF THE MONTHS IN THE NORTHERN TEMPERATE AND POLAR ZONES					-	-	-	-	12	11	9	7	5	3	1	2	4	6	8	10	
SECTION 50° TO c. 45° 0′ N																					
83	Victoria	48° 25′	123° 23′ W	25	8	1881-88	3,69	0	12	11	9	7	5	3	1	2	4	6	8	10	
84	Olympia	47° 3′	122° 53′ W	10	15	1870-84	4,26	0	12	11	9	7	5	3	1	2	4	6	8	10	
85	Winnipeg	49° 55′	97° 7′ W	226	14	1871-84	12,91	4	12	10	9	7	4	3	1	2	5	6	8	11	
86	Montreal	45° 31′	73° 33′ W	57	15	1870-84	10,13	0	12	11	9	7	5	3	1	2	4	6	8	10	
87	Quebec	46° 48′	71° 12′ W	95	15	1870-84	10,21	0	12	11	9	7	5	3	1	2	4	6	8	10	±2,70°C
88	Anticosti, W. P.	49° 52′	64° 30′ W	0	15	1870-84	8,36	2	12	11	9	7	5	3	2	1	4	6	8	10	
89	Anticosti, S. W. P.	49° 24′	63° 16′ W	6	15	1870-84	7,94	6	12	11	9	7	6	4	2	1	3	5	8	10	
90	St. Johns, N. F.	47° 34′	52° 42′ W	46	15	1870-84	6,21	12	11	12	10	8	6	4	2	1	3	5	7	9	
91	North Atlantic	47° 30′	47° 30′ W	0	$5^2/_3$	-	4,35	12	11	12	10	8	6	4	2	1	3	5	7	9	
92	North Atlantic	47° 30′	27° 30′ W	0	$5^2/_3$	-	2,34	12	11	12	10	8	6	4	2	1	3	5	7	9	
93	North Atlantic	47° 30′	12° 30′ W	0	$5^2/_3$	-	2,40	8	12	11	9	8	6	4	2	1	3	5	7	10	
94	Brest	48° 23′	4° 23′ W	63	15	1870-84	3,67	6	12	11	9	7	6	4	2	1	3	5	8	10	
95	Paris	48° 50′	2° 21′ E	78	15	1870-84	4,91	6	11	10	8	7	5	3	1	2	4	6	9	12	±4,60
96	Gr. St. Bernard	45° 52′	7° 11′ E	2480	15	1870-84	5,15	4	12	10	9	7	5	4	1	2	3	6	8	11	
97	Stuttgart	48° 47′	9° 11′ E	270	15	1870-84	5,97	8	11	10	8	6	5	3	1	2	4	7	9	12	
98	Vienna	48° 14′	16° 22′ E	202	15	1870-84	6,66	6	12	10	8	7	4	3	1	2	5	6	9	11	±3,93
99	Buda-Pesth	47° 30′	19° 2′ E	153	15	1870-84	7,23	6	12	10	8	6	5	3	1	2	4	7	9	11	±4,37
100	Charkow	50° 4′	36° 9′ E	126	15	1870-84	8,81	4	12	11	9	6	4	3	1	2	5	7	8	10	
101	Astrakhan	46° 21′	48° 2′ E	-21	15	1870-84	9,98	2	12	11	9	7	4	3	1	2	5	6	8	10	
102	Gurjew	47° 7′	51° 55′ E	-18	15	1870-84	10,99	4	12	11	9	6	4	3	1	2	5	7	8	10	
103	Irgis	48° 37′	61° 16′ E	112	15	1870-84	13,23	4	12	11	9	6	4	3	1	2	5	7	8	10	
104	Semipolatinsk	50° 24′	80° 13′ E	181	15	1870-84	13,05	4	12	11	9	7	4	2	1	3	5	6	8	10	±8,58
105	Urga	47° 55′	106° 50′ E	1311	15	1870-84	13,05	6	12	10	8	6	5	3	1	2	4	7	9	11	
106	Chaborowka	48° 26′	135° 7′ E	18	15	1870-84	14,41	6	12	10	8	6	5	3	1	2	4	7	9	11	
107	P. Karoosakowsky	46° 39′	142° 48′ E	20	$2^1/_2$	various	8,75	6	12	11	9	7	6	4	2	1	3	5	8	10	
SECTION 45° TO c. 40° 0′ N																					
108	Roseburg	43° 13′	123° 20′ W	156	15	1870-84	4,51	4	12	10	8	7	5	3	1	2	4	6	9	11	
109	Salt Lake City	40° 46′	111° 54′ W	1326	$10^3/_4$	1874-84	7,88	4	12	10	8	7	5	3	1	2	4	6	9	11	
110	Omaha	41° 16′	95° 56′ W	339	15	1870-84	9,54	2	12	10	9	7	5	3	1	2	4	6	8	11	
111	Chicago	41° 52′	87° 38′ W	201	15	1870-84	8,51	2	12	10	9	7	5	3	1	2	4	6	8	11	±3,04°C
112	New York	40° 43′	74° 0′ W	50	15	1870-84	8,05	0	12	11	9	7	5	3	1	2	4	6	8	10	±3,89
113	Mount Washington	44° 16′	71° 18′ W	1914	13	1872-84	8,13	0	12	11	9	7	5	3	1	2	4	6	8	10	
114	North Atlantic	42° 30′	67° 30′ W	0	$5^2/_3$	-	6,28	10	12	11	10	8	6	4	2	1	3	5	7	9	
115	Halifax	44° 39′	63° 66′ W	37	15	1870-84	7,51	6	12	11	9	7	6	4	2	1	3	5	8	10	
116	North Atlantic	42° 30′	42° 30′ W	0	$5^2/_3$	-	3,58	12	11	12	10	8	6	4	2	1	3	5	7	9	
117	North Atlantic	42° 30′	27° 30′ W	0	$5^2/_3$	-	2,60	12	11	12	10	8	6	4	2	1	3	5	7	9	
118	North Atlantic	42° 30′	12° 30′ W	0	$5^2/_3$	-	2,86	8	12	11	9	8	6	4	2	1	3	5	7	10	
119	Madrid	40° 22′	3° 42′ W	655	15	1870-84	6,31	6	11	10	8	7	5	3	1	2	4	6	9	12	±8,18
120	La Grande-Sauve	44° 46′	0° 19′ W	100	15	1870-84	4,81	4	12	10	8	7	5	3	1	2	4	6	9	11	
121	Marseilles	43° 17′	5° 22′ E	75	15	1870-84	4,78	0	12	11	9	7	5	3	1	2	4	6	8	10	
122	Ajaccio	41° 55′	8° 44′ E	18	15	1870-84	4,70	6	12	11	9	7	6	4	2	1	3	5	8	10	
123	Genoa	44° 25′	8° 55′ E	54	15	1870-84	5,25	4	12	10	9	7	5	4	1	2	3	6	8	11	

continued

No.	PLACE	Lati-tude	Longi-tude	Height, metres	PERIOD: number of years	PERIOD: the years	MV °C	Total displacement	January	February	March	April	May	June	July	August	Septemb.	Octob.	Novbr.	Decbr.	$\Sigma (\pm \Delta m)$
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
NORMAL ORDER OF THE MONTHS IN THE NORTHERN TEMPERATE AND POLAR ZONES		-	-	-	-	-	-	-	12	11	9	7	5	3	1	2	4	6	8	10	
SECTION 45° TO c. 40° 0′ N, continued																					
124	Rome	41° 54′	12° 29′ E	50	15	1870-84	5,56	2	12	10	9	7	5	3	1	2	4	6	8	11	±3,82 °C
125	Pola	44° 52′	13° 50′ E	32	15	1870-84	5,84	0	12	11	9	7	5	3	1	2	4	6	8	10	
126	Naples	40° 52′	14° 15′ E	149	15	1870-84	5,24	0	12	11	9	7	5	3	1	2	4	6	8	10	
127	Sophia	42° 32′	23° 23′ E	538	15	1870-84	7,92	4	12	10	9	6	5	3	1	2	4	7	8	11	
128	Constantinople	41° 0′	28° 59′ E	0	15	1870-84	5,86	4	11	12	10	7	5	3	1	2	4	6	8	9	±6,13
129	Sebastopol	44° 37′	33° 31′ E	61	15	1870-84	6,65	4	11	12	10	7	5	3	1	2	4	6	8	9	
130	Baku	40° 22′	49° 50′ E	2	15	1870-84	7,44	8	11	12	10	8	5	3	2	1	4	6	7	9	
131	Port Alexandrowsky	44° 31′	50° 15′ E	-25	15	1870-84	9,30	0	12	11	9	7	5	3	1	2	4	6	8	10	
132	Krassnowodsk	40° 0′	52° 39′ E	-21	15	1870-84	8,17	2	12	11	9	7	5	3	2	1	4	6	8	10	
133	Taschkent	41° 19′	69° 16′ E	462	15	1870-84	8,49	8	12	11	8	6	4	2	1	3	5	7	9	10	
134	Wjernoje	43° 16′	76° 53′ E	744	15	1870-84	11,21	4	12	11	9	6	4	3	1	2	5	7	8	10	
135	Kuldscha	43° 56′	80° 56′ E	520	4	various	11,18	8	12	11	8	6	4	2	1	3	5	7	9	10	
136	Wladiwostock	43° 7′	131° 54′ E	17	10	1875-85	10,49	6	12	10	9	7	5	4	2	1	3	6	8	11	
137	Olga	43° 44′	135° 20′ E	45	10	1875-85	9,71	8	12	10	8	7	5	4	2	1	3	6	9	11	
138	Hakodate	41° 46′	140° 44′ E	3	14	1859-86	7,31	6	12	11	9	7	6	4	2	1	3	5	8	10	
139	Sapporo	43° 4′	141° 23′ E	18	6	1881-86	8,59	4	12	11	9	7	5	4	2	1	3	6	8	10	
SECTION 40° TO c. 35° 0′ N																					
140	St. Francisko	37° 48′	122° 26′ W	18	15	1870-84	1,53	18	12	10	9	8	6	3	4	5	1	2	7	11	
141	Sacramento	38° 35′	121° 30′ W	20	15	1870-84	4,69	4	12	10	8	7	5	3	1	2	4	6	9	11	
142	Santa Fé	35° 41′	105° 57′ W	2167	13	1870-82	7,27	4	12	10	8	7	5	3	1	2	4	6	9	11	
143	St. Louis	38° 27′	90° 12′ W	174	15	1870-84	8,34	2	12	10	9	7	5	3	1	2	4	6	8	11	±2,60 °C
144	Washington	38° 54′	77° 2′ W	32	15	1870-84	7,98	0	12	11	9	7	5	3	1	2	4	6	8	10	
145	Cape Hatteras	35° 14′	75° 30′ W	2	15	1870-84	6,08	0	12	11	9	7	5	3	1	2	4	6	8	10	
146	North Atlantic	37° 30′	72° 30′ W	0	$5^2/_3$	-	5,83	8	12	11	10	8	6	4	1	2	3	5	7	9	
147	North Atlantic	37° 30′	57° 30′ W	0	$5^2/_3$	-	3,79	14	10	12	11	8	6	4	2	1	3	5	7	9	
148	North Atlantic	37° 30′	42° 30′ W	0	$5^2/_3$	-	3,07	12	11	12	10	8	6	4	2	1	3	5	7	9	
149	North Atlantic	37° 30′	27° 30′ W	0	$5^2/_3$	-	2,62	14	11	12	10	8	6	5	2	1	3	4	7	9	
150	North Atlantic	37° 30′	12° 30′ W	0	$5^2/_3$	-	2,76	10	12	10	9	8	6	4	2	1	3	5	7	11	
151	Lisbon	38° 42′	9° 8′ W	102	15	1870-84	3,43	10	11	10	9	7	6	4	2	1	3	5	8	12	±4,70
152	Gibraltar	36° 8′	5° 20′ W	16	15	1870-84	3,69	10	11	10	9	7	6	4	2	1	3	5	8	12	±4,82
153	Valencia	39° 28′	0° 23′ W	18	15	1870-84	4,69	6	12	10	9	7	5	4	2	1	3	6	8	11	
154	Algiers	36° 47′	3° 4′ E	22	15	1870-84	4,20	8	12	10	9	7	6	4	2	1	3	5	8	11	
155	Cagliari	39° 30′	9° 0′ E	55	15	1870-84	4,76	8	12	10	9	7	6	4	2	1	3	5	8	11	
156	Malta	35° 53′	14° 30′ E	21	15	1870-84	4,29	10	12	11	10	8	6	4	2	1	3	5	7	9	
157	Messina	38° 12′	15° 39′ E	54	15	1870-84	4,98	6	12	11	9	7	6	4	2	1	3	5	8	10	
158	Corfu	39° 38′	19° 33′ E	30	15	1870-84	5,31	4	12	11	10	7	6	3	1	2	4	5	8	9	
159	Athens	37° 58′	23° 44′ E	103	24	1859-82	6,08	0	12	11	9	7	5	3	1	2	4	6	8	10	±4,03
160	Smyrna	38° 26′	27° 10′ E	8	7	1864-70	5,88	0	12	11	9	7	5	3	1	2	4	6	8	10	
161	Beyrout	35° 28′	35° 54′ E	34	11	1876-86	4,37	12	11	12	10	8	6	4	2	1	3	5	7	9	
162	Eriwan	40° 10′	44° 30′ E	985	15	1870-84	9,98	2	12	11	9	7	5	3	2	1	4	6	8	10	
163	Ashur-Ade	36° 54′	53° 35′ E	-24	15	1870-84	7,58	4	12	11	9	7	5	4	2	1	3	6	8	10	
164	Merv	37° 36′	61° 46′ E	285	1	1885-86	9,60	4	11	12	9	6	5	3	1	2	4	7	8	10	

continued

No.	PLACE	Lati-tude	Longi-tude	Height, metres	PERIOD		MV	Total displacement	January	February	March	April	May	June	July	August	Septemb.	Octob.	Novbr.	Decbr.	$\Sigma (\pm \Delta m)$
					number of years	the years	°C														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
NORMAL ORDER OF THE MONTHS IN THE NORTHERN TEMPERATE AND POLAR ZONES					-	-	-	-	12	11	9	7	5	3	1	2	4	6	8	10	
SECTION 40° TO c. 35° 0′ N, continued																					
165	Samarkand	39° 39′	66° 57′ E	725	15	1870-84	8,12	8	12	11	8	6	4	2	1	3	5	7	9	10	±9,38°C
166	Margelan	40° 28′	71° 43′ E	610	15	1870-84	9,58	6	12	11	8	6	4	3	1	2	5	7	9	10	
167	Pekin	39° 57′	116° 28′ E	37	15	1870-84	10,03	2	12	10	9	7	5	3	1	2	4	6	8	11	
168	Tientsin	39° 9′	117° 16′ E	9	15	1870-84	9,65	4	12	10	8	7	5	3	1	2	4	6	9	11	
169	Taku	38° 59′	117° 40′ E	5	15	1870-84	9,80	8	12	10	8	6	4	3	1	2	5	7	9	11	
170	Fusan	35° 6′	129° 2′ E	10	2½	1884-86	7,53	4	12	11	9	7	5	4	2	1	3	6	8	10	
171	Kioto	35° 1′	135° 46′ E	50	6	1881-86	7,72	6	12	11	9	7	6	4	2	1	3	5	8	10	
172	Niigata	37° 55′	139° 3′ E	10	6	1881-86	7,43	8	11	12	9	7	6	4	2	1	3	5	8	10	
173	Tokio	35° 41′	139° 45′ E	21	14	1872-86	7,08	4	12	11	9	7	5	4	2	1	3	6	8	10	
174	Miyako	39° 38′	141° 59′ E	30	6	1881-86	6,97	8	11	12	9	7	6	4	2	1	3	5	8	10	
SECTION 35° TO c. 30° 0′ N																					
175	San Diego	32° 43′	117° 10′ W	20	15	1870-84	2,69	6	12	11	9	7	6	4	2	1	3	5	8	10	
176	Galveston	29° 18′	94° 47′ W	12	15	1870-84	5,38	4	12	10	8	7	5	3	1	2	4	6	9	11	
177	New Orleans	29° 58′	90° 4′ W	16	15	1870-84	4,98	4	12	10	8	7	5	3	1	2	4	6	9	11	±2,50°C
178	Memphis	35° 9′	90° 3′ W	10	15	1870-84	7,08	4	12	10	8	7	5	3	1	2	4	6	9	11	
179	Savannah	32° 5′	81° 5′ W	27	15	1870-84	5,45	4	12	10	8	7	5	3	1	2	4	6	9	11	
180	Charleston	32° 49′	79° 56′ W	15	15	1870-84	5,73	2	12	10	9	7	5	3	1	2	4	6	8	11	
181	North Atlantic	32° 30′	77° 30′ W	0	5⅔	-	5,31	0	12	11	9	7	5	3	1	2	4	6	8	10	
181a	Bermuda	32° 17′	64° 14′ W	37	15	1870-84	3,40	12	11	12	10	8	6	4	2	1	3	5	7	9	±7,35
182	North Atlantic	32° 30′	57° 30′ W	0	5⅔	-	2,88	18	10	11	12	9	7	4	2	1	3	5	6	8	
183	North Atlantic	32° 30′	42° 30′ W	0	5⅔	-	2,56	20	11	12	10	9	7	5	3	1	2	4	6	8	
184	North Atlantic	32° 30′	27° 30′ W	0	5⅔	-	2,24	22	10	12	11	9	7	5	3	1	2	4	6	8	
185	North Atlantic	32° 30′	12° 30′ W	0	5⅔	-	2,30	16	11	12	9	8	7	5	3	1	2	4	6	10	
186	Mogador	31° 30′	9° 44′ W	17	7½	various	1,80	4	12	11	9	7	6	3	2	1	4	5	8	10	
187	Tangier	35° 45′	5° 47′ W	61	6	1879-85	3,56	8	11	10	9	7	5	4	2	1	3	6	8	12	
188	Biskra	34° 5′	5° 40′ E	125	15	1870-84	6,68	4	12	10	8	7	5	3	1	2	4	6	9	11	
189	Tripoli	32° 53′	13° 11′ E	30	4	1819-21	4,09	12	12	11	9	8	6	5	3	1	2	4	7	10	
190	Alexandria	31° 12′	29° 53′ E	19	15	1870-84	3,66	10	12	11	10	8	6	4	2	1	3	5	7	9	
191	Port Said	31° 16′	32° 18′ E	6	5½	1880-85	4,13	8	12	11	9	8	6	4	2	1	3	5	7	10	
192	Suez	29° 59′	32° 31′ E	7	5½	1880-85	5,06	2	12	11	9	7	6	3	1	2	4	5	8	10	
193	Jerusalem	31° 47′	35° 13′ E	732	19	1863-81	5,10	4	12	11	9	7	6	3	2	1	4	5	8	10	±5,42
194	Bagdad	33° 21′	44° 26′ E	12	1	1861-62	7,89	4	12	10	9	7	4	3	1	2	5	6	8	11	
195	Quetta	30° 11′	67° 3′ E	1677	8	1868-85	6,68	6	11	12	8	6	5	3	1	2	4	7	9	10	
196	Mooltan	30° 10′	71° 33′ E	128	15	1870-84	6,87	12	12	10	8	6	4	1	2	3	5	7	9	11	
197	Peshavar	34° 2′	71° 37′ E	338	15	1870-84	7,24	12	12	10	8	6	4	1	2	3	5	7	9	11	
198	Hankow	30° 32′	114° 19′ E	80	5	1877-81	8,02	0	12	11	9	7	5	3	1	2	4	6	8	10	
199	Shanghai	31° 14′	121° 28′ E	0	18	1847-64	7,80	2	12	11	9	7	5	4	1	2	3	6	8	10	
200	Nagasahi	32° 44′	129° 52′ E	58	13	1871-86	6,75	4	12	11	9	7	6	4	1	2	3	5	8	10	
201	Osaka	34° 42′	135° 30′ E	4	6	1881-86	7,55	4	12	11	9	7	5	4	2	1	3	6	8	10	

No.	PLACE	Lati-tude	Longi-tude	Height, metres	PERIOD: number of years	PERIOD: the years	MV °C	Total displacement	January	February	March	April	May	June	July	August	Septemb.	Octob.	Novbr.	Decbr.	$\Sigma (\pm \Delta m)$
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
NORMAL ORDER OF THE MONTHS IN THE NORTHERN TEMPERATE AND POLAR ZONES				-	-	-	-	-	12	11	9	7	5	3	1	2	4	6	8	10	
SECTION 30° TO c. 23° 21′ N																					
202	Brownsville	25° 53′	97° 26′ W	18	15	1870-84	4,50	4	12	10	8	7	5	3	1	2	4	6	9	11	
203	Punta Rassa	26° 9′	82° 1′ W	4	15	1870-84	3,16	2	12	10	9	7	5	3	1	2	4	6	8	11	
204	Key West	24° 34′	81° 49′ W	6	15	1870-84	2,49	6	12	10	9	7	5	4	2	1	3	6	8	11	
205	Nassau	25° 5′	77° 21′ W	13	15	1870-84	1,85	8	12	11	9	8	6	4	2	1	3	5	7	10	
206	North Atlantic	27° 30′	77° 30′ W	0	$5^2/_3$	-	3,35	0	12	11	9	7	5	3	1	2	4	6	8	10	
207	North Atlantic	27° 30′	57° 30′ W	0	$5^2/_3$	-	2,13	18	10	12	11	9	7	4	2	1	3	5	6	8	
208	North Atlantic	27° 30′	42° 30′ W	0	$5^2/_3$	-	1,94	22	10	11	12	9	7	5	3	1	2	4	6	8	
209	North Atlantic	27° 30′	22° 30′ W	0	$5^2/_3$	-	1,91	22	10	12	11	9	7	5	3	2	1	4	6	8	
210	Las Palmas	27° 28′	17° 48′ W	9	5	1880-84	1,89	16	11	12	9	8	7	5	3	1	2	4	6	10	
211	Red Sea	29° 0′	33° 0′ E	0	-	-	3,56	10	12	11	10	8	6	4	2	1	3	5	7	9	
212	Red Sea	27° 0′	34° 20′ E	0	-	-	2,81	10	12	11	10	8	6	4	2	1	3	5	7	9	
213	Red Sea	25° 0′	35° 40′ E	0	-	-	2,53	14	12	11	10	8	6	5	3	1	2	4	7	9	
214	Bushire	28° 59′	50° 49′ E	8	9	1878-86	5,86	4	12	11	9	7	5	4	2	1	3	6	8	10	
215	Kurrachee	24° 47′	67° 4′ E	15	15	1870-84	3,41	16	12	10	8	6	2	1	3	5	4	7	9	11	
216	Delhi	28° 40′	77° 16′ E	219	15	1870-84	5,82	18	12	10	8	5	2	1	3	4	6	7	9	11	
217	Agra	27° 10′	78° 5′ E	169	15	1870-84	5,65	22	12	10	8	3	2	1	4	5	6	7	9	11	
218	Benares	25° 20′	83° 2′ E	81	15	1870-84	5,14	24	11	10	8	3	1	2	4	5	6	7	9	12	
219	Darjeeling	27° 3′	88° 18′ E	2262	17	1868-84	3,81	2	12	11	8	7	5	3	1	2	4	6	9	10	
220	Kiukiang	29° 44′	116° 8′ E	55	4	1878-81	7,98	0	12	11	9	7	5	3	1	2	4	6	8	10	
221	Foochow	26° 1′	119° 38′ E	10	$1^1/_2$	1886-87	5,11	6	11	12	9	7	6	3	2	1	4	5	8	10	
222	Kelung	25° 20′	121° 46′ E	15	2	1873-75	4,63	4	12	11	10	8	5	3	1	2	4	6	7	9	
THE TROPICAL ZONE																					
NORMAL ORDER OF THE MONTHS IN THE PARALLEL c. 23° 21′ N		-		-	-	-	-	-	12	11	9	7	5	3	1	2	4	6	8	10	
223	Havana	23° 8′	82° 23′ W	19	19	1858-76	2,05	4	12	10	9	7	5	2	1	3	4	6	8	11	$\pm$1,61 °C
224	North Atlantic	22° 30′	72° 30′ W	0	$5^2/_3$	-	2,00	8	12	11	10	8	6	4	1	2	3	5	7	9	
225	North Atlantic	22° 30′	62° 30′ W	0	$5^2/_3$	-	1,70	20	10	12	11	8	7	5	3	1	2	4	6	9	
226	North Atlantic	22° 30′	42° 30′ W	0	$5^2/_3$	-	1,59	22	11	10	12	9	7	5	3	1	2	4	6	8	
227	North Atlantic	22° 30′	22° 30′ W	0	$5^2/_3$	-	1,58	28	10	12	11	9	8	6	4	2	1	3	5	7	
228	Red Sea	23° 0′	37° 0′ E	0	-	-	2,38	16	11	12	10	8	6	5	3	1	2	4	7	9	$\pm$6,52
229	Mascat	23° 38′	58° 36′ E	10	$3^3/_4$	various	3,94	10	12	11	9	7	2	1	3	4	5	6	8	10	$\pm$7,36
230	Calcutta	22° 32′	88° 20′ E	7	15	1870-84	3,16	22	12	10	8	3	1	2	4	6	5	7	9	11	
231	Hong Kong	22° 18′	114° 10′ E	13	15	1870-84	4,74	0	12	11	9	7	5	3	1	2	4	6	8	10	
IN THE PARALLEL c. 20° 0′ N		-		-	-	-	-	-	12	11	9	7	5	2	3	1	4	6	8	10	
232	Honolulu	21° 18′	157° 50′ W	10	$2^1/_3$	1885-87	1,28	18	11	10	9	8	7	5	3	2	1	4	6	12	
233	Colima	19° 12′	103° 33′ W	82	11	1869-80	1,13	20	11	12	7	4	3	2	1	6	5	8	9	10	
234	Mexico	19° 26′	99° 0′ W	2283	9	1877-85	1,86	28	12	9	6	1	2	3	4	5	7	8	10	11	
235	Red Sea	21° 0′	38° 10′ E	0	-	-	2,27	16	11	12	10	8	7	5	3	1	2	4	6	9	
236	Djedda	21° 30′	39° 22′ E	6	6	1881-86	2,69	12	11	12	10	8	6	4	2	1	3	5	7	9	
237	Bombay	18° 54′	72° 49′ E	11	15	1870-84	1,32	20	12	11	8	3	1	2	4	6	7	5	9	10	
238	Cuttack	20° 9′	85° 54′ E	24	15	1870-84	2,81	28	11	9	7	2	1	3	4	5	6	8	10	12	$\pm$13,63
239	Akyab	20° 28′	92° 54′ E	6	15	1870-84	2,13	28	12	10	8	2	1	5	7	6	3	4	9	11	$\pm$ 8,16

No.	PLACE	Lati-tude	Longi-tude	Height, metres	PERIOD: number of years	PERIOD: the years	MV °C	Total displacement	January	February	March	April	May	June	July	August	Septemb.	Octob.	Novbr.	Decbr.	Σ ($\pm \Delta m$)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	THE TROPICAL ZONE																				
	NORMAL ORDER OF THE MONTHS IN THE PARALLEL c. 17° 30′ N		-	-	-	-	-	-	12	11	9	7	5	1	4	3	2	6	8	10	
240	Kingston	18° 1′	76° 48′ W	3	8	1880-87	0,98	14	11	12	10	8	6	4	1	3	2	5	7	9	±2,69 °C
241	Christiansted	17° 45′	64° 42′ W	25	9	1877-85	1,13	12	11	12	9	8	6	4	3	1	2	5	7	10	±1,51
242	North Atlantic	17° 30′	57° 30′ W	0	$5^2/_3$	-	1,20	16	11	12	10	8	6	5	3	1	2	4	7	9	
243	North Atlantic	17° 30′	42° 30′ W	0	$5^2/_3$	-	1,24	20	12	11	10	9	7	6	4	2	1	3	5	8	
244	North Atlantic	17° 30′	22° 30′ W	0	$5^2/_3$	-	1,40	28	10	12	11	9	8	6	5	3	1	2	4	7	
245	St. Louis	16° 7′	16° 30′ W	5	$5^1/_2$	1873-78	2,59	28	12	8	9	11	10	6	4	3	1	2	5	7	
246	Red Sea	17° 0′	40° 40′ E	0	-	-	2,19	14	12	11	10	8	6	4	1	2	3	5	7	9	
247	Secunderabad	17° 27′	78° 33′ E	545	15	1870-84	2,56	36	11	9	3	2	1	4	5	6	7	8	10	12	±16,63
248	Visagapatam	17° 42′	83° 22′ E	10	15	1870-84	2,04	22	11	10	8	3	1	2	5	4	6	7	9	12	± 5,87
249	Rangoon	16° 46′	96° 12′ E	13	15	1870-84	1,05	36	12	10	3	1	2	5	7	9	7	4	8	11	
	IN THE PARALLEL c. 15° 0′ N		-	-	-	-	-	-	12	11	9	7	3	2	5	4	1	6	8	10	
250	Praya	14° 54′	23° 31′ W	34	5	1875-79	1,38	24	12	11	10	9	7	6	5	1	2	3	4	8	±5,40
251	Red Sea	15° 0′	42° 0′ E	0	-	-	2,34	12	12	11	9	7	6	4	3	1	2	5	8	10	±3,59
252	Manila	14° 35′	120° 59′ E	17	15	1870-84	0,91	26	12	10	4	2	1	3	5	6	7	8	9	11	±4,29
	IN THE PARALLEL c. 12° 30′ N		-	-	-	-	-	-	12	11	9	7	2	3	6	4	1	5	8	10	
253	Barbadoes	13° 4′	59° 40′ W	8	15	1870-84	0,55	8	12	11	9	7	2	1	5	3	4	6	8	10	±0,78
254	North Atlantic	12° 30′	52° 30′ W	0	$5^2/_3$	-	0,98	26	10	11	12	9	7	6	4	2	1	3	5	8	
255	North Atlantic	12° 30′	42° 30′ W	0	$5^2/_3$	-	0,96	26	11	12	10	9	8	6	4	2	1	3	5	7	
256	North Atlantic	12° 30′	22° 30′ W	0	$5^2/_3$	-	0,94	28	11	12	10	9	8	6	5	4	2	1	3	7	
257	Kouka	13° 10′	14° 30′ E	275	2	Dove	1,83	30	11	8	4	1	2	3	6	9	7	5	10	12	
258	Kouka	12° 52′	13° 23′ E	280	$2^1/_2$	1870-72	2,85	26	11	10	4	1	2	3	6	9	7	5	8	12	±13,30
259	Red Sea	12° 40′	45° 0′ E	0	-	-	1,75	8	12	11	9	7	3	1	4	5	2	6	8	10	± 1,87
260	Aden	12° 45′	45° 3′ E	30	$4^1/_2$	1880-84	2,14	12	12	10	8	7	3	1	4	5	2	6	9	11	± 3,32
261	Mangalore	12° 52′	74° 54′ E	16	15	1870-84	1,01	44	12	7	3	1	2	5	11	10	9	6	4	8	± 8,06
262	Bangalore	12° 59′	77° 38′ E	909	15	1870-84	1,70	30	12	9	3	1	2	4	5	6	7	8	10	11	±10,11
263	Madras	13° 4′	80° 14′ E	7	15	1870-84	2,04	22	12	10	7	4	1	2	3	5	6	8	9	11	± 5,42
	IN THE PARALLEL c. 10° 0′ N		-	-	-	-	-	-	12	11	9	6	1	4	7	5	2	3	8	10	
264	Rivas	11° 26′	85° 47′ W	46	7	1880-86	0,28	58	3	7	9	2	1	6	12	10	8	11	4	5	
265	San José	9° 56′	84° 0′ W	1145	11	1868-78	0,79	48	9	3	2	1	4	5	6	8	7	10	11	12	±5,98
266	Colon	9° 22′	79° 55′ W	50	5	1881-85	0,25	46	7	9	8	5	1	2	6	11	12	10	3	4	±1,87
267	Gamboa	9° 10′	79° 43′ W	30	4	various	0,71	26	11	12	10	9	4	1	5	7	2	6	3	8	
268	Caraccas	10° 30′	66° 53′ W	928	3	1868-70	0,86	14	12	11	9	4	1	2	6	3	5	7	8	10	±1,57
269	St. Ann's Trinidad	10° 30′	61° 20′ W	40	18	1862-80	0,50	18	11	12	10	9	1	5	8	7	2	3	6	4	±1,49
270	Cochin	9° 58′	76° 17′ E	4	15	1870-84	0,92	58	8	4	2	1	3	9	12	11	10	6	5	7	±8,20
271	Negapatam	10° 46′	79° 53′ E	5	15	1870-84	1,63	24	11	10	7	3	1	2	4	5	6	8	9	12	
272	Saigon	10° 47′	106° 42′ E	3	6	1874-79	0,93	28	12	9	3	2	1	4	5	6	7	8	10	11	

No.	PLACE	Lati-tude	Longi-tude	Height, metres	PERIOD		MV	Total displacement	January	February	March	April	May	June	July	August	Septemb.	Octob.	Novbr.	Decbr.	$\Sigma (\pm \Delta m)$
					number of years	the years	°C														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	THE TROPICAL ZONE																				
	NORMAL ORDER OF THE MONTHS IN THE PARALLEL c. 7° 30′ N		-	-	-	-	-	-	12	11	9	4	1	5	7	6	3	2	8	10	
273	Georgetown	6° 50′	58° 8′ W	3	8	1846-56	0,38	30	8	11	7	5	6	9	12	4	1	2	3	10	
274	Freetown	8° 30′	13° 9′ W	69	9	1875-83	0,68	50	6	4	3	1	2	5	10	12	11	9	8	7	
275	Kandy	7° 18′	80° 40′ E	517	15	1870-84	0,71	32	12	5	3	1	2	4	9	8	6	7	10	11	±4,06 °C
276	Batticalao	7° 43′	81° 44′ E	8	15	1870-84	1,27	26	12	10	8	5	3	1	2	4	6	7	9	11	±4,70
277	Nancowry	8° 0′	93° 46′ E	25	15	1870-84	0,53	40	9	4	3	1	2	5	6	8	7	11	10	12	
	IN THE PARALLEL c. 5° 0′ N		-	-	-	-	-	-	12	11	9	3	2	5	8	7	4	1	6	10	
278	Cayenne	4° 56′	55° 39′ W	2	7	1846-52	0,52	24	11	12	9	6	7	8	5	3	2	1	4	10	±2,46
279	Paramaribo	5° 50′	55° 13′ W	2	15	1870-84	0,75	26	12	11	9	8	7	6	4	1	2	3	5	10	
280	Christiansborg	5° 24′	0° 10′ W	20	7 ½	1829-40	1,08	50	8	5	2	1	3	9	11	12	10	7	4	6	±9,39
281	Lado	5° 2′	31° 50′ E	465	4	1880-83	1,39	62	3	1	2	4	6	9	11	12	10	8	7	5	±15,06
282	Galle	6° 1′	80° 14′ E	15	15	1870-84	0,48	26	12	9	3	1	2	4	7	6	5	8	10	11	
283	Penang	5° 24′	100° 20′ E	6	2	1885-86	0,77	48	6	4	1	2	3	5	7	8	12	10	11	9	±6,38
	IN THE PARALLEL c. 2° 30′ N		-	-	-	-	-	-	12	11	7	2	3	6	9	8	4	1	5	10	
284	Malacca	2° 10′	102° 14′ E	4	2	1885-86	0,26	42	10	4	1	2	5	7	3	11	6	8	9	12	±1,91
285	Singapore	1° 15′	103° 31′ E	7	15	1870-84	0,63	32	11	3	1	2	5	6	8	10	7	4	9	12	
	THE EQUATOR 0° 0′	-	-	-	-	-	-	-	12	9	6	1	4	7	11	10	5	2	3	8	
286	Quito	0° 14′ S	78° 45′ W	2851	1 ½	1878-79	0,42	50	2	1	9	12	5	10	11	7	8	6	3	4	±3,44
287	Antisana	0° 21′ S	78° 6′ W	4061	1	1845-46	0,88	42	1	7	4	3	6	9	12	11	10	8	5	2	±5,83
288	St. Thomas	0° 20′ N	6° 43′ E	5	11	1870-82	0,58	46	5	2	1	3	6	10	12	11	9	8	7	4	±4,18
289	Gabun	0° 25′ N	9° 35′ E	20	4	1880-85	0,85	40	4	2	3	1	5	11	12	10	9	8	7	6	±5,70
290	Padang	0° 56′ S	100° 2′ E	73	4	1850-53	0,22	46	7	5	3	2	1	4	6	10	8	12	11	9	
	IN THE PARALLEL 2° 20′ S		-	-	-	-	-	-	10	8	4	1	5	9	12	11	6	2	3	7	
291	Porto do Maranhao	2° 30′ S	44° 0′ W	4	1 ½	1886-87	0,35	44	6	7	8	12	10	11	9	4	1	2	3	5	±2,65
292	Lahat	3° 12′	104° 36′ E	251	8	1845-52	0,30	32	12	10	4	1	2	5	6	8	9	3	7	11	
292a	Palembang	2° 50′	104° 53′ E	6	6	various	0,24	28	12	8	5	4	1	7	9	10	2	3	6	11	±1,15
293	Bandjermassing	3° 0′	114° 30′ E	3	8	1851-58	0,29	22	9	8	6	2	1	4	12	10	7	3	5	11	
294	Amboina	3° 45′	128° 15′ E	12	5	1850-54	0,66	38	3	2	5	6	7	9	12	11	10	8	4	1	
	IN THE PARALLEL 5° 0′ S		-	-	-	-	-	-	9	7	4	1	6	10	12	11	8	3	2	5	
295	Chinchoxo	5° 9′	12° 3′ E	12	6	1880-85	1,42	24	6	2	1	5	8	10	12	11	9	7	3	4	±5,40
296	Rubaga	5° 24′	33° 33′ E	1300	3	1877-81	0,45	18	8	7	1	2	4	9	10	12	11	5	3	6	±2,00
297	Zanzibar	6° 10′	39° 11′ E	7	11	1874-84	0,97	34	3	2	1	5	7	9	11	12	10	8	6	4	
298	Batavia	6° 11′	106° 50′ E	7	15	1870-84	0,30	42	12	11	8	2	1	6	9	7	3	5	4	10	
299	Bismarck Island	4° 20′	152° 30′ E	0	2	1883-84	0,39	50	7	1	6	12	2	4	8	10	11	9	5	3	
	IN THE PARALLEL 7° 30′ S		-	-	-	-	-	-	7	6	3	2	8	10	12	11	9	4	1	5	
300	Victoria	8° 9′	35° 27′ W	161	7	1876-84	1,16	28	2	1	4	6	7	9	12	11	10	8	5	3	
301	Pernambuco	8° 4′	34° 52′ W	3	8	1876 84	1,36	24	2	1	4	7	8	10	12	11	9	6	5	3	
302	Ascension	7° 55′	14° 25′ W	16	2	1863-65	1,06	44	6	3	1	2	4	5	7	9	12	11	10	8	±7,54
303	Banjoewangi	8° 17′	114° 27′ E	8	8	1850-57	0,35	14	6	9	2	1	7	8	11	12	10	4	3	5	

No.	PLACE	Lati-tude	Longi-tude	Height, metres	PERIOD		MV	Total displacement	January	February	March	April	May	June	July	August	Septemb.	Octob.	Novbr.	Decbr.	$\Sigma (\pm \Delta m)$
					number of years	the years	°C														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	THE TROPICAL ZONE																				
	NORMAL ORDER OF THE MONTHS IN THE PARALLEL 10° 0′ S		-	-	-	-	-	-	7	5	2	3	8	10	12	11	9	6	1	4	
304	Colonia Isobet	8° 45′	35° 42′ W	230	6	1876-84	1,24	18	3	6	1	5	8	9	11	12	10	7	4	2	
305	St. Paul de Loando	8° 49′	13° 7′ E	59	5	1878-82	2,23	14	6	1	2	3	7	9	12	11	10	8	4	5	
306	Somerset, Cape York	10° 44′	142° 36′ E	21	$2^1/_3$	1865-67	0,90	22	4	3	5	6	7	9	11	12	10	8	2	1	$\pm$2,74 °C
	IN THE PARALLEL 12° 30′ S		-	-	-	-	-	-	6	4	1	5	8	10	12	11	9	7	2	3	
307	Callao	12° 4′	77° 14′ W	0	?	1857-70	2,13	16	2	4	1	6	7	9	10	12	11	8	5	3	$\pm$4,64
308	St. Bento das Lagas	12° 37′	38° 40′ W	30	10	1872-81	1,45	14	2	1	4	6	8	10	12	11	9	7	5	3	$\pm$2,26
309	Bahia	12° 58′	38° 30′ W	100	$3^1/_2$	1881-84	1,35	14	1	2	3	5	8	10	12	11	9	7	6	4	$\pm$2,64
310	Port Darwin	12° 28′	130° 51′ E	21	5	1878-82	1,39	20	6	7	5	3	9	11	12	10	8	2	1	4	$\pm$3,88
	IN THE PARALLEL 15° 0′ S		-	-	-	-	-	-	5	3	1	6	8	10	12	11	9	7	4	2	
311	St. Helena	15° 55′	5° 43′ W	12	6	1856-62	1,31	22	4	2	1	3	5	8	11	12	10	9	7	6	
312	Daly Waters	16° 16′	133° 22′ E	229	5	1878-82	2,74	22	3	5	6	8	9	11	12	10	7	4	1	2	
313	Sweers Island	15° 0′	136° 0′ E	10	$2^1/_2$	1868-71	2,58	14	4	6	3	5	9	11	12	10	8	7	2	1	$\pm$4,73
	IN THE PARALLEL 17° 30′ S		-	-	-	-	-	-	4	2	3	6	8	10	12	11	9	7	5	1	
314	Tahiti	17° 32′	149° 34′ W	0	5	1855-60	0,89	20	5	3	1	2	6	9	11	12	10	8	7	4	$\pm$2,84
315	Delanasau	16° 38′	178° 37′ E	23	5	1876-80	0,79	10	2	3	4	5	7	9	12	11	10	8	6	1	
316	Levuka	18° 13′	179° 3′ E	24	11	1875-85	1,26	14	1	2	3	5	7	9	11	12	10	8	6	4	
	IN THE PARALLEL 20° 0′ S		-	-	-	-	-	-	3	2	4	6	8	10	12	11	9	7	5	1	
317	Iquiqne	20° 12′	70° 11′ W	10	3	1883-86	1,85	6	1	3	4	6	9	10	12	11	8	7	5	2	$\pm$1,83
318	Queluz	20° 40′	44° 38′ W	1000	$2^1/_2$	1882-83,87	2,38	10	3	1	2	7	9	10	12	11	8	6	5	4	
319	St. Denis, Reunion	20° 50′	55° 15′ E	16	3	1883-85	1,82	12	3	1	2	5	7	10	11	12	9	8	6	4	$\pm$2,63
320	Mauritius, R. O.	20° 6′	57° 33′ E	54	15	1870-84	1,89	12	1	2	3	5	7	9	12	11	10	8	6	4	$\pm$3,10
321	Rodriguez	19° 48′	63° 10′ E	3	11	1876-86	1,86	12	1	2	3	5	7	10	11	12	9	8	6	4	$\pm$3,40
322	Cossack	20° 40′	117° 8′ E	6	$4^1/_2$	1881-85	3,85	10	2	1	4	7	9	11	12	10	8	6	5	3	$\pm$5,83
323	Ravenswood	20° 20′	146° 50′ E	183	$2^1/_2$	1870-73	2,82	6	3	1	4	6	9	11	12	10	8	7	5	2	$\pm$2,96
324	Hollow Mackay	21° 10′	149° 11′ E	61	4	1876-79	3,49	12	2	4	5	7	9	11	12	10	8	6	3	1	
	IN THE PARALLEL 25° 6′ S		-	-	-	-	-	-	1	2	4	6	8	10	12	11	9	7	5	3	
325	Punta Caldera	27° 5′	70° 50′ W	25	3	1883-86	2,23	4	1	2	3	5	8	10	12	11	9	7	6	4	
326	Salta	24° 46′	65° 24′ W	1230	7	1873-82	3,29	14	2	3	5	7	9	12	11	10	8	6	4	1	$\pm$7,11
327	Tucuman	26° 51′	65° 12′ W	464	7	1873-85	3,98	10	1	3	5	7	9	11	12	10	8	6	4	2	$\pm$6,84
328	Villa Formosa	26° 13′	58° 10′ W	100	4	1879-82	3,34	8	1	2	4	7	10	11	12	9	8	6	5	3	
329	Assuncion	25° 16′	57° 40′ W	100	3	1855-57	3,72	12	1	2	5	7	10	12	11	9	8	6	4	3	$\pm$6,03
330	Joinville	26° 19′	53° 48′ W	?	8	1867-75	2,81	4	1	2	4	6	9	11	12	10	8	7	5	3	
331	San Paulo	23° 33′	46° 37′ W	730	5	1879-83	2,51	4	1	2	4	6	9	11	12	10	8	7	5	3	
332	Monopolole	24° 0′	25° 0′ E	1143	4	1880-83	3,81	12	2	1	5	8	9	11	12	10	7	6	4	3	
333	Pretoria	25° 45′	28° 50′ E	1360	$3^1/_3$	1875-78	2,23	6	1	2	4	7	9	11	12	10	8	6	5	3	$\pm$4,96
334	Lorenzo Marques	25° 28′	32° 37′ E	5	$1^3/_4$	1876-78	2,63	8	2	1	3	6	7	11	12	10	9	8	5	4	$\pm$3,95
335	Alice Springs	23° 38′	133° 37′ E	640	5	1878-82	5,64	10	1	3	5	7	9	11	12	10	8	6	4	2	
336	Moreton Bay	27° 1′	153° 28′ E	100	15	1870-84	2,95	2	1	2	4	6	8	11	12	10	9	7	5	3	$\pm$2,49

No.	PLACE	Lati-tude	Longi-tude	Height, metres	PERIOD		MV	Total displacement	January	February	March	April	May	June	July	August	Septemb.	Octob.	Novbr.	Decbr.	$\Sigma (\pm \Delta m)$
					number of years	the years	°C														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
NORMAL ORDER OF THE MONTHS IN THE SOUTHERN TEMPERATE AND POLAR ZONES					-	-	-	-	1	2	4	6	8	10	12	11	9	7	5	3	
SECTION 25° 6′ TO 30° 0′ S																					
337	Coquimbo	29° 56′	71° 21′ W	22	4	1869-72	1,93	8	2	3	5	6	8	11	12	10	9	7	4	1	
338	Serena	29° 55′	71° 17′ W	35	4	1869-72	1,88	4	2	1	4	6	8	11	12	10	9	7	5	3	
339	Copiapo	27° 22′	70° 23′ W	395	5	1868-72	2,78	6	1	2	4	7	9	11	12	10	8	6	5	3	±2,98°C
340	Rioja	29° 20′	67° 15′ W	541	4	1875-78	4,88	14	1	3	4	8	10	12	11	9	7	6	5	2	
341	Goya	29° 0′	59° 15′ W	61	10	1876-86	3,60	8	1	2	4	7	10	11	12	9	8	6	5	3	±4,03
342	Corrientes	27° 28′	58° 49′ W	85	7	1873-80	3,46	8	2	1	4	6	9	12	11	10	8	7	5	3	
343	Sao Leopoldo & Santa Cruz	29° 35′	52° 30′ W	110	5	1869-73	3,82	4	2	1	4	6	9	10	12	11	8	7	5	3	
344	Springbok	29° 40′	17° 53′ E	976	4	1882-86	3,49	2	1	2	4	6	8	11	12	10	9	7	5	3	±3,07
345	Kimberley	28° 48′	25° 2′ E	1238	15	1870-84	4,70	8	1	2	5	7	9	11	12	10	8	6	4	3	±7,49
346	Blomfontein	28° 56′	26° 19′ E	1387	15	1870-84	4,64	10	1	3	5	7	9	11	12	10	8	6	4	2	
347	Fort Napier	29° 3′	30° 2′ E	701	15	1870-84	2,38	10	2	1	3	7	9	11	12	10	8	6	5	4	
348	Pietermaritzburg	29° 30′	30° 20′ E	638	10	1858-67	2,75	12	2	1	4	7	10	12	11	9	8	6	5	3	±6,08
349	Durban	29° 50′	31° 0′ E	46	5	1876-80	2,07	6	2	1	4	6	7	11	12	10	9	8	5	3	
350	Geraldton	28° 47′	114° 26′ E	2	6	1880-85	2,95	4	2	1	3	6	8	10	12	11	9	7	5	4	±2,53
351	Thergomindal	28° 0′	142° 30′ E	137	15	1870-84	5,66	6	1	2	4	7	9	11	12	10	8	6	5	3	±6,93
352	Tenterfield	29° 5′	152° 4′ E	854	15	1870-84	4,04	10	1	3	5	7	9	11	12	10	8	6	4	2	
353	Toowoomba	27° 34′	152° 10′ E	600	15	1870-84	3,96	10	1	3	5	7	9	11	12	10	8	6	4	2	
354	Brisbane	27° 28′	153° 6′ E	40	15	1870-84	3,32	4	1	3	4	6	8	11	12	10	9	7	5	2	±2,24
SECTION 30° TO c. 35° 0′ S																					
355	Valparaiso	33° 1′	71° 40′ W	46	10	1863-72	1,90	0	1	2	4	6	8	10	12	11	9	7	5	3	±1,14
356	Santiago de Chili	33° 27′	70° 41′ W	519	21	1860-81	3,57	8	1	2	5	7	9	11	12	10	8	6	4	3	±2,97
357	Mendosa	32° 53′	68° 49′ W	805	6	1875-80	5,34	14	3	1	5	7	9	12	11	10	8	6	4	2	
358	Cordova	31° 25′	64° 11′ W	445	$4^1/_3$	1872-76	4,04	14	1	3	5	8	9	12	11	10	7	6	4	2	
359	Rosario	32° 57′	60° 38′ W	39	6	1875-80	4,01	6	1	2	4	6	9	12	11	10	8	7	5	3	
360	Villa Hermandarius	31° 15′	59° 40′ W	59	8	1877-84	4,40	6	1	2	4	7	9	11	12	10	8	6	5	3	
361	Buenos Ayres	34° 39′	58° 23′ W	4	21	1856-76	4,30	4	1	2	4	6	9	11	12	10	8	7	5	3	±2,85
362	Monte Video	34° 54′	56° 13′ W	12	10	1843-52	3,80	0	1	2	4	6	8	10	12	11	9	7	5	3	±1,96
363	Rio Grande do Sul	32° 0′	52° 15′ W	16	9	various	3,47	4	1	2	3	6	8	11	12	10	9	7	5	4	±2,49
364	Cape Town	33° 56′	18° 27′ E	11	15	1870-84	2,63	0	1	2	4	6	8	10	12	11	9	7	5	3	±1,09
365	Clan William	32° 10′	18° 53′ E	91	10	various	4,05	6	1	2	4	7	9	11	12	10	8	6	5	3	
366	Worcester	33° 40′	19° 27′ E	238	15	1870-84	3,43	4	1	2	4	6	9	11	12	10	8	7	5	3	
367	Sutherland	32° 24′	20° 40′ E	1458	15	1870-84	4,31	6	1	2	4	7	9	11	12	10	8	6	5	3	
368	Brakfontein	31° 52′	23° 0′ E	1250	15	1870-84	4,73	8	1	2	5	7	9	11	12	10	8	6	4	3	
369	Port Elisabeth	33° 57′	25° 37′ E	55	15	1870-84	2,25	0	1	2	4	6	8	10	12	11	9	7	5	3	±1,52
370	East London	33° 2′	27° 55′ E	12	15	1870-84	2,07	0	1	2	4	6	8	10	12	11	9	7	5	3	±1,44
371	Bunbury	33° 19′	115° 39′ E	5	6	1880-85	2,80	2	2	1	4	6	8	10	12	11	9	7	5	3	
372	Perth	31° 37′	115° 52′ E	14	10	1876-85	3,69	6	2	1	3	6	8	11	12	10	9	7	5	4	±2,64
373	Eucla	31° 45′	128° 58′ E	2	15	1870-84	2,78	6	1	2	3	5	8	11	12	10	9	7	6	4	
374	Adelaide	34° 57′	138° 35′ E	43	15	1870-84	3,82	2	1	2	4	6	8	11	12	10	9	7	5	3	±3,02
375	Wentworth	34° 8′	142° 0′ E	44	15	1870-84	4,84	6	1	2	4	7	9	11	12	10	8	6	5	3	
376	Bourke	30° 3′	145° 58′ E	139	15	1870-84	5,65	6	1	2	4	7	9	11	12	10	8	6	5	3	±5,10
377	Bathurst	33° 24′	149° 37′ E	671	15	1870-84	4,93	4	1	2	4	6	9	11	12	10	8	7	5	3	
378	Sydney	33° 52′	151° 11′ E	47	15	1870-84	3,27	4	1	2	4	6	9	11	12	10	8	7	5	3	±2,91

No.	PLACE	Lati-tude	Longi-tude	Height, metres	PERIOD		MV °C	Total displacement	January	February	March	April	May	June	July	August	Septemb.	Octob.	Novbr.	Decbr.	Σ ($\pm \Delta m$)
					number of years	the years															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
NORMAL ORDER OF THE MONTHS IN THE SOUTHERN TEMPERATE AND POLAR ZONES					-	-	-	-	1	2	4	6	8	10	12	11	9	7	5	3	
SECTION 35° TO c. 40° 0′ S																					
379	Corral	39° 52′	73° 17′ W	32	3	1870-72	2,43	2	1	2	4	6	8	10	11	12	9	7	5	3	
380	Valdivia	39° 49′	73° 17′ W	13	15	18 ? -75	2,75	0	1	2	4	6	8	10	12	11	9	7	5	3	$\pm$1,52°C
381	Quinquina	36° 37′	73° 3′ W	58	3	1883-86	2,85	2	1	2	4	6	8	11	12	10	9	7	5	3	
382	Talca	35° 26′	71° 46′ W	105	2	1871-72	4,70	6	1	2	4	7	9	11	12	10	8	6	5	3	
383	Bahia Blanca	38° 45′	62° 11′ W	15	14	1870-83	4,75	10	1	2	5	7	9	12	11	10	8	6	4	3	$\pm$5,04
384	Tandil	37° 17′	59° 8′ W	198	6	1876-82	4,29	4	1	2	4	6	8	12	11	10	9	7	5	3	$\pm$3,21
385	Albany	35° 2′	117° 54′ E	27	6	1880-85	2,38	6	2	1	4	5	7	10	12	11	9	8	6	3	$\pm$2,82
386	Cape Borda	35° 45′	136° 35′ E	154	15	1870-84	2,10	8	1	2	3	5	7	9	12	11	10	8	6	4	
387	Mount Gambier	37° 50′	140° 50′ E	39	15	1870-84	2,77	6	2	1	3	5	8	10	12	11	9	7	6	4	
388	Portland	38° 21′	141° 32′ E	11	15	1870-84	2,36	6	2	1	3	5	8	10	12	11	9	7	6	4	
389	Kings Island	39° 35′	144° 5′ E	41	5	1861-66	2,43	8	1	2	3	5	8	12	11	10	9	7	6	4	
390	Melbourne	37° 50′	144° 50′ E	28	15	1870-84	3,09	8	2	1	3	6	9	11	12	10	8	7	5	4	$\pm$4,52
391	Gabo Island	37° 35′	149° 30′ E	15	15	1870-84	2,62	8	3	1	2	5	8	10	12	11	9	7	6	4	
392	Auckland	36° 50′	174° 51′ E	79	15	1870-84	2,77	6	2	1	3	5	8	10	12	11	9	7	6	4	
393	Napier	39° 29′	176° 55′ E	2	15	1870-84	2,85	0	1	2	4	6	8	10	12	11	9	7	5	3	$\pm$1,92
PLACES SOUTH OF 40° 0′ S																					
394	Puerta Mont	41° 30′	72° 57′ W	6	4	1869-72	2,32	6	2	1	4	7	8	10	11	12	9	6	5	3	
395	Punta Arenas	53° 8′	70° 52′ W	10	8	1853-61	2,84	4	1	2	4	7	9	10	12	11	8	6	5	3	$\pm$2,31
396	Ushaia	54° 53′	68° 10′ W	30	7 1/2	1876-82	3,20	4	1	2	5	6	9	10	12	11	8	7	4	3	$\pm$4,40
397	Chubut	43° 18′	65° 15′ W	30	3 1/4	1880-83	5,40	12	1	2	5	7	10	12	11	9	8	6	4	3	
398	Port Hanley	51° 42′	57° 48′ W	7	4 1/2	various	2,39	10	2	1	5	7	8	12	11	10	9	6	4	3	
399	Cape Pembroke	51° 41′	57° 47′ W	0	9	1859-68	1,94	10	2	3	1	6	8	11	12	10	9	7	4	5	$\pm$3,08
400	Hobart Town	42° 52′	147° 21′ E	11	15	1870-84	2,55	6	2	1	4	6	9	11	12	10	8	7	5	3	$\pm$2,93
401	Southland	46° 17′	168° 20′ E	24	15	1870-84	2,72	4	1	2	4	6	9	11	12	10	8	7	5	3	
402	Queenstown	45° 2′	168° 39′ E	326	15	1870-84	3,71	2	1	2	4	6	9	10	12	11	8	7	5	3	
403	Christchurch	43° 32′	172° 39′ E	7	15	1870-84	3,31	2	1	2	4	6	9	10	12	11	8	7	5	3	$\pm$2,07
404	Nelson	41° 16′	173° 19′ E	10	15	1870-84	3,07	2	1	2	4	6	9	10	12	11	8	7	5	3	
405	Wellington	41° 16′	174° 47′ E	43	15	1870-84	2,65	4	1	2	3	5	8	10	12	11	9	7	6	4	$\pm$2,36

PROSPECT OF GEOGRAPHICAL POSITIONS

BETWEEN THE ARCTIC POLE AND THE PARALLEL ON 30°N.

CONSTRUCTED BY LIEUT. COL. AXEL STAGGEMEIER

COPENHAGEN.

PL. I.

Length of one degree
expressed in Kilometres

Latitude	on the parallels of latitude	on the meridian
30°	96,492	110,847
35°	91,294	110,937
40°	85,400	111,033
45°	78,853	111,132
50°	71,702	111,232
55°	64,000	111,328
60°	55,805	111,419
65°	47,180	111,501
70°	38,191	111,572
75°	28,905	111,629
80°	19,396	111,672
85°	9,736	111,698

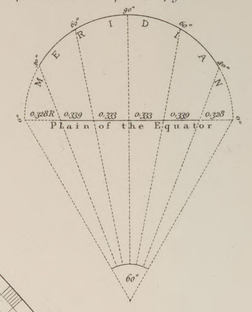
Time Difference
in comparison with the difference of Longitude = 4 minutes pro 1°

Measures

1 geographical mile = 7421,46 Metres = 1/5400 of the Equator
1 Sea-Mile = 1852,3 " = 1/5400 of the Meridian Quadrant
1 english mile = 1524,00 "
1 geographical □mile = 51,11 □ Kilometres

Method of Projection

Pl. I and Pl. V, including resp. the northern and the southern quarter of terrestrial zones, are drawn by centralprojection on the plain of Equator, as explained on the present figure.



The mean yearly temperature at sea-level of a place is composed of two parts, and may be expressed thus: $M = T\varphi + t(\varphi,\lambda)$. The figures, inscribed on this map, indicate for the given geographical positions and in degrees Centigrade »the annual thermo-geographical component $(t\varphi,\lambda)$«, due to the thermal action of the surface itself; figures (and marks) in red denote a positive and in blue a negative value of the component. For intermediate positions the component may be interpolated, either by the numericals given on this map, or, more complete, in the tables II-IV and the Codification, accompanying the »Thermo-Geographical Studies«.

The whole surface of the earth amounts to 510,500 □ Kilometres
The part, represented on this plan, forms 1/4 of the whole area.

To find the mean yearly temperature of a place, add to the component $(t\varphi,\lambda)$ the normal mean yearly temperature of the parallel or lat. φ of the place, determined by the formula

$T\varphi = 31{,}7544\ cos\ \varphi + 18{,}6395\ cos\ \varphi^2 - 21{,}7620$.

The term $T\varphi$ may also be interpolated by the subjoined table, or by the detailed tables, given in the Codification.

Table for interpolation of $T\varphi$:

90°	−21,762°C	65°	−5,013°C	40°	+13,501°C
85°	−18,853	60°	−1,225	35°	16,757
80°	−15,686	55°	+2,584	30°	19,718
75°	−12,295	50°	6,351	25°	22,328
70°	− 8,721	45°	10,012	20°	24,537

February 1897. *C. L. Madsen.*

Lithograferet af N.P. KELLER

AXEL E. AAMODT, COPENHAGEN.

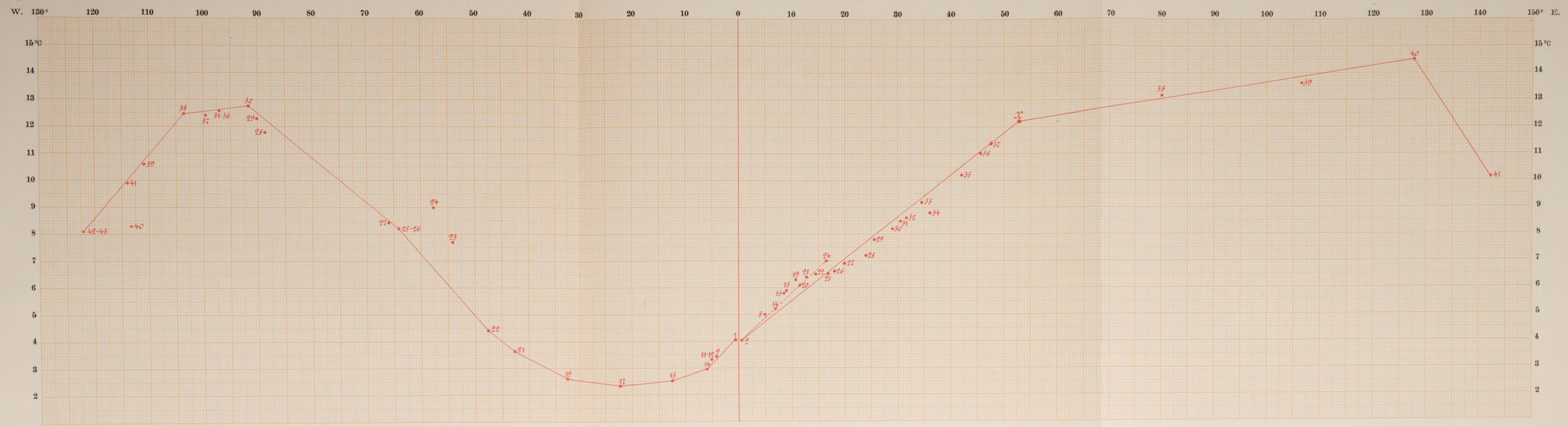
APPENDIX TO „THERMO-GEOGRAPHICAL STUDIES".

1897.

DIAGRAM I.

GRAPHICAL REPRESENTATION OF THE MOVEMENT OF THE THERMO-GEOGRAPHICAL COEFFICIENT MV IN THE PARALLEL 50° N.

PLAN II.



POINTS OF INFLEXION AND MEAN PROGRESS OF THE COEFFICIENT MV IN THE PARALLEL 50° N. THROUGH NORTH-AMERICA.

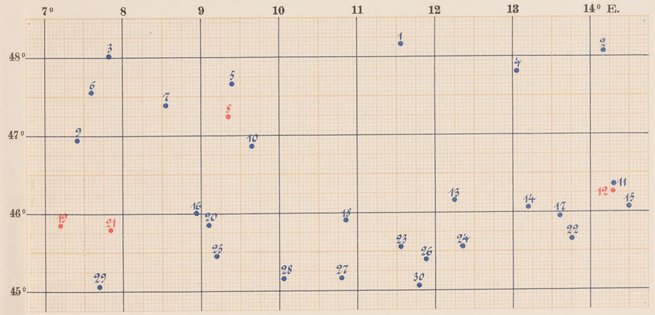
1	Range in degrees of longitude. 2	MV 3	Mean increase (+) or decrease (—) of MV for each degree of long. 4
64° 20′ (25—27) to 91° 40′ (30)	27° 20′	8,22 to 12,78	+0,1668
91° 40′ (30) to 103° 42′ (38)	12° 2′	12,78 to 12,51	−0,0225
103° 42′ (38) to 121° 46′ (42—43)	18° 4′	12,51 to 8,14	−0,2420
	= 57° 26′		

POSITIONS IN THE WESTERN LONG. OF THE PARALLEL 50° N.

	φ	λ	H	MV
1. Caen	49° 11′	0° 21′	21	4,06
2. Osborne	50° 45′	1° 16′	53	4,65
3. Jersey	49° 12′	2° 7′	15	3,64
4. Guernsey	49° 28′	2° 32′	63	3,30
5. Columpton	50° 51′	3° 23′	62	3,77
6. Exeter	50° 43′	3° 31′	50	3,96
7. Babbacombe	50° 29′	3° 31′	90	3,52
8. Trawle Point	50° 13′	3° 44′	107	3,31
9. Dartmoor	50° 33′	3° 59′	418	4,44
10. Bude	50° 50′	4° 37′	5	3,48
11. Truro	50° 17′	5° 4′	13	3,47
12. Falmouth	50° 9′	5° 4′	64	3,11
means of 11-12.	-	5° 4′	-	3,29
13. Helston	50° 7′	5° 12′	32	3,26
14. Scilly	49° 55′	6° 18′	30	2,87
15. North Atlantic	50° 0′	12° 30′	-	2,47
16. do.	50° 0′	17° 30′	-	2,20
17. do.	50° 0′	22° 30′	-	2,27
18. do.	50° 0′	27° 30′	-	2,36
19. do.	50° 0′	32° 30′	-	2,63
20. do.	50° 0′	37° 30′	-	3,01
21. do.	50° 0′	42° 30′	-	3,62
22. do.	50° 0′	47° 30′	-	4,40
23. Fogs	49° 44′	54° 11′	28	7,89
24. Point Rich	50° 38′	57° 20′	-	9,00
25. Anticosti, S. W. P.	49° 24′	63° 16′	6	7,94
26. Anticosti, W. P.	49° 52′	64° 30′	-	8,86
27. Cape Magdalen	49° 14′	65° 15′	-	8,86
means of 25-27.	-	64° 20′	-	8,22
28. Nepigon	50° 0′	88° 40′	228	11,76
29. Savanne	49° 48′	90° 4′	228	12,30
30. Stony Mountain	50° 22′	91° 40′	226	12,78
31. Gimli	50° 37′	96° 58′	222	12,08
32. St. Andrews	50° 5′	97° 0′	396	13,74
33. Pembina	49° 0′	97° 5′	241	11,96
34. Winnipeg	49° 55′	97° 7′	225	12,91
35. Rockwood	50° 5′	97° 12′	?	12,29
36. Poplar Heights	50° 4′	97° 47′	?	12,35
means of 31-36.	-	97° 11′	-	12,56
37. Minnedosa	50° 13′	99° 48′	548	12,37
38. Qu'Appelle	50° 44	103° 42′	645	12,51
39. Medicine Hat	50° 1′	110° 37′	651	10,61
40. Fort M'Leod	49° 39′	113° 12′	731	8,26
41. Calgary	50° 55′	114° 4′	1082	9,91
42. Spences Bridge	50° 25′	121° 30′	231	8,52
43. Lillooet	50° 42′	122° 2′	198	7,76
means of 42-43.	-	121° 46′	-	8,14

DIAGRAM 2.

COMPARISON OF THE THERMO-GEOGRAPHICAL COEFFICIENT MV TO HEIGHTS IN THE ALPINE REGIONS.



POSITIONS IN THE DIAGRAM 2.

	φ	λ	H	MV
1. Munich	48° 9′	11° 34′	529	6,2315
2. Kremsmünster	48° 4′	14° 8′	384	6,4444
3. Freiburg	48° 0′	7° 51′	291	5,8333
4. Salzburg	47° 48′	13° 3′	436	6,4452
5. Friedrichshafen	47° 39′	9° 25′	408	5,9815
6. Basel	47° 33′	7° 35′	278	5,9418
7. Zurich	47° 23′	8° 33′	480	6,0370
8. Säntis	47° 15′	9° 20′	2468	4,4722
9. Berne	46° 57′	7° 26′	573	5,9266
10. Chur	46° 50′	9° 38′	590	6,1541
11. Klagenfurt	46° 37′	14° 18′	438	7,7516
12. Obirgipfel	46° 30′	14° 17′	2044	4,9630
13. Belluno	46° 8′	12° 14′	404	6,5184
14. Udino	46° 4′	13° 13′	116	6,3148
15. Laibach	46° 3′	14° 30′	287	6,7315
16. Lugano	46° 0′	8° 57′	275	6,0648
17. Görz	45° 57′	13° 37′	94	6,6370
18. Riva	45° 53′	10° 50′	84	6,1111
19. Gr. St. Bernard	45° 52′	7° 11′	2482	5,0742
20. Como	45° 51′	9° 7′	112	6,5000
21. Valdobbia	45° 47′	7° 51′	2549	4,9815
22. Trieste	45° 39′	13° 46′	26	6,1852
23. Vicenza	45° 33′	11° 32′	56	6,8426
24. Venice	45° 32′	12° 20′	21	6,6667
25. Milan	45° 28′	9° 11′	147	6,9982
26. Padua	45° 24′	11° 53′	34	6,7037
27. Mantua	45° 10′	10° 47′	40	7,3518
28. Cremona	45° 8′	10° 3′	68	7,2222
29. Turin	45° 3′	7° 41′	276	6,6389
30. Rovigo	45° 3′	11° 47′	9	7,1760

POINTS OF INFLEXION AND MEAN PROGRESS OF THE COEFFICIENT MV IN THE PARALLEL OF 50° N. THROUGH EUROPE AND ASIA.

1	Range in degrees of longitude. 2	MV 3	Mean increase (+) or decrease (—) of MV for each degree of long. 4
0° 22′ (2) to 52° 59′ (x)	52° 37′	4,00 to 12,23	+0,1568
52° 59′ (x) to 127° 38′ (40)	74° 39′	12,23 to 14,51	+0,0305
127° 38′ (40) to 142° 7′ (41)	14° 29′	14,51 to 10,11	−0,3039
	= 141° 45′		

POSITIONS IN THE EASTERN LONG. OF THE PARALLEL 50° N.

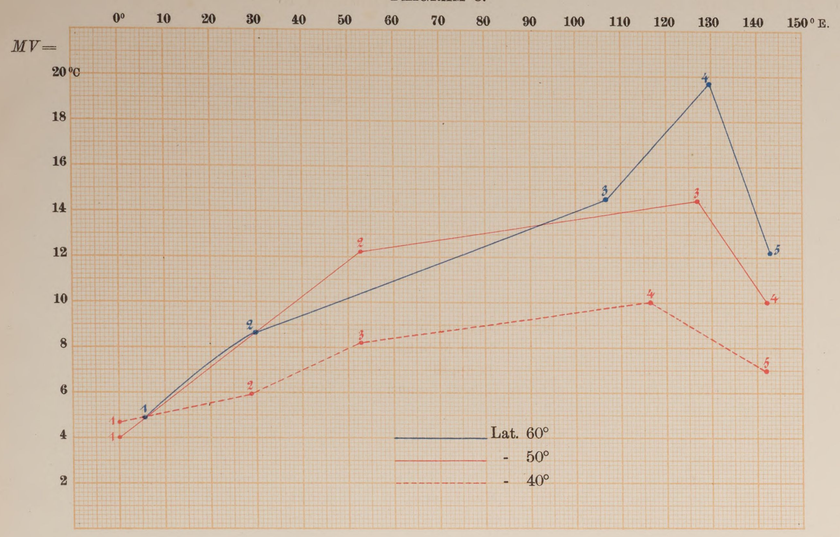
	φ	λ	H	MV
1. Brighton	50° 49′	−0° 8′	63	4,30
2. Fécamp	49° 46′	+0° 22′	19	4,00
3. Rouen	49° 26′	1° 5′	12	4,68
4. Amiens	49° 54′	2° 18′	31	5,05
5. Arras	50° 18′	2° 46′	73	4,80
6. Brussels	50° 51′	4° 22′	57	4,98
7. Charleville	49° 46′	4° 43′	145	5,36
8. Namur	50° 28′	4° 51′	150	4,97
9. Liège	50° 41′	5° 33′	61	5,01
10. Maestricht	50° 52′	5° 37′	53	5,40
11. Aachen	50° 47′	6° 5′	177	5,04
12. Luxemburg	49° 37′	6° 8′	311	5,10
13. Trier	49° 45′	6° 38′	150	5,41
14. Cologne	50° 56′	6° 57′	60	5,19
15. Carlsruhe	49° 0′	8° 25′	123	5,77
16. Frankfurt	50° 10′	8° 37′	104	6,11
17. Heidelberg	49° 24′	8° 42′	121	5,56
18. Aschaffenburg	49° 59′	9° 9′	137	5,94
19. Bamberg	49° 54′	10° 54′	243	6,31
20. Bayreuth	49° 57′	11° 35′	345	6,09
21. Eger	50° 5′	12° 22′	455	6,41
22. Prague	50° 5′	14° 25′	201	6,46
23. Leipa	50° 41′	14° 32′	253	6,42
24. Brunn	49° 11′	16° 36′	211	6,96
25. Barzdorff	50° 25′	17° 6′	258	6,46
26. Ratibor	50° 6′	18° 13′	197	6,56
27. Cracow	50° 4′	19° 57′	220	6,86
28. Lemberg	49° 50′	24° 1′	298	7,19
29. Tarnopol	49° 36′	25° 36′	317	7,77
30. Ssoschanskoe	49° 34′	28° 55′	280	8,22
31. Kiew	50° 27′	30° 30′	183	8,54
32. Goroditschsche	49° 17′	31° 27′	90	8,57
33. Poltawa	49° 33′	34° 38′	140	9,20
34. Charkow	50° 4′	36° 9′	126	8,81
35. Urjupinskaja	50° 48′	42° 0′	82	10,21
36. Kamyschin	50° 5′	45° 24′	21	10,99
37. Malyi-Usen	50° 31′	47° 37′	29	11,39
x. calculated	-	52° 59′	-	12,23
38. Semipolatinsk	50° 24′	80° 13′	181	13,05
39. Kjachta	50° 20′	106° 35′	718	13,62
40. Blagowetschensk	50° 15′	127° 38′	110	14,51
41. Due	50° 50′	142° 7′	100	10,11

Axel E. Arnoot, Kjøbenhavn.

GRADIENTS OF THE THERMO-GEOGRAPHICAL COEFFICIENT MV IN DIFFERENT PARALLELS

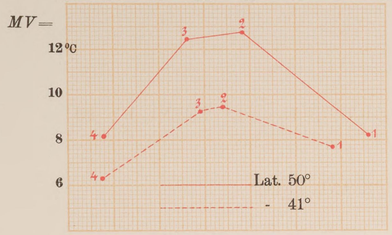
THROUGH EUROPE AND ASIA.

DIAGRAM 3.



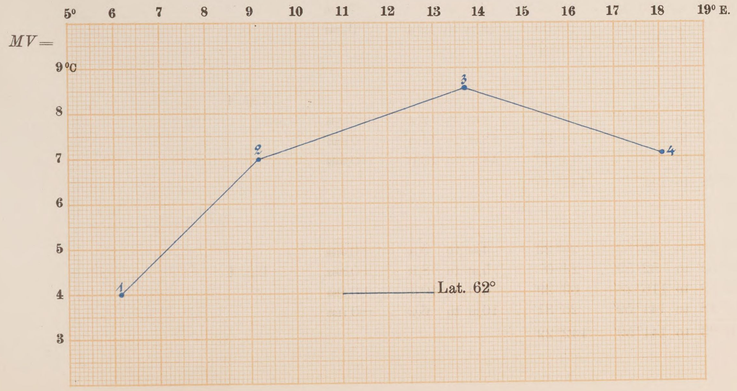
THROUGH NORTH-AMERICA.

DIAGRAM 4.



THROUGH THE SCANDINAVIAN PENINSULA.

DIAGRAM 5.



POINTS OF INFLEXION AND POSITIONS MARKED OR REFERRED TO IN THE DIAGRAMS, PLAN III.

IN PARALLELS THROUGH EUROPE AND ASIA.

DIAGRAM 3.

		φ	λ	h	MV
Lat. 60°	1. Bergen	60° 24′	5° 20′	18	4,66
	2. St. Petersburg	59° 56′	30° 16′	6	8,61
	Narym	59° 21′	80° 16′	60	12,49
	3. Calculated	-	106° 52′	-	14,55
	Banschtschikowa	58° 3′	108° 35′	300	14,96
	4. Yakutsk	62° 2′	129° 45′	102	19,72
	Marchinskoe	62° 10′	129° 43′	163	19,71
	5. Okhotsk	59° 20′	142° 40′	4	12,30
Lat. 50°	1. Fécamp	49° 56′	0° 22′	19	4,30
	Malyi-Usen	50° 31′	47° 37′	29	11,39
	2. Calculated	-	52° 59′	-	12,23
	Semipolatinsk	50° 24′	80° 13′	181	13,05
	3. Blagowetschensk	50° 15′	127° 38′	110	14,51
	4. Due	50° 50′	142° 7′	100	10,11
Lat. 40°	1. Valencia	39° 28′	−0° 23′	18	4,69
	2. Constantinople	41° 0′	28° 59′	-	5,86
	Batum	41° 43′	41° 38′	3	5,71
	Tiflis	41° 43′	44° 47′	409	7,56
	3. Krasnowodsk	40° 0′	52° 59′	−21	8,17
	4. Pekin	39° 57′	116° 28′	37	10,03
	5. Miyako	39° 38′	141° 59′	30	6,97

IN PARALLELS THROUGH NORTH-AMERICA.

DIAGRAM 4.

		φ	λ	h	MV
Lat. 50°	1. Anticosti W.P. (means)	49° 52′	64° 20′	-	8,22
	2. Stony Mountain	50° 22′	91° 40′	226	12,78
	3. Qu'Appelle	50° 44′	103° 42′	645	12,51
	4. Lillooet (means)	50° 42′	121° 46′	198	8,14
Lat. 41°	1. New London	41° 21′	72° 5′	14	7,69
	2. Omaha	41° 16′	95° 56′	339	9,54
	3. North Platte	41° 8′	100° 45′	866	9,27
	4. Red Bluff	40° 10′	122° 15′	101	6,29

IN PARALLELS THROUGH THE SCANDINAVIAN PENINSULA.

DIAGRAM 5.

		φ	λ	h	MV
Lat. 62°	1. Aalesund	62° 29′	6° 9′	14	4,08
	2. Dovre	62° 5′	9° 8′	643	7,00
	Tönset	62° 17′	10° 45′	493	7,52
	Röraas	62° 24′	11° 23′	629	7,66
	3. Calculated	-	13° 42′	-	8,33
	Sweg	62° 2′	14° 23′	320	8,14
	4. Hernösand	62° 38′	17° 58′	14	7,11

RELATION OF THE THERMO-GEOGRAPHICAL COEFFICIENT MV TO GEOGRAPHICAL POSITIONS IN NORTHERN PARALLELS,

IN PARALLELS THROUGH EUROPE AND ASIA.

	Gradient	Range in degrees of long.		MV.	Ratio to 1° long. + increasing — decreasing
Lat. 60°	Atlantic	5° 20′ to 30° 16′	24° 56′	4,66 to 8,61	+0,1580
	Continental	30° 16′ to 106° 52′	76° 36′	8,61 to 14,55	+0,0775
	Polar	106° 52′ to 129° 45′	22° 53′	14,55 to 19,72	+0,2260
	Pacific	129° 45′ to 142° 40′	12° 55′	19,72 to 12,30	−0,5748
		5° 20′ to 142° 40′	137° 20′		
Lat. 50°	Atlantic	0° 22′ to 52° 59′	52° 37′	4,00 to 12,23	+0,1568
	Continental	52° 59′ to 127° 38′	74° 39′	12,23 to 14,51	+0,0305
	Pacific	127° 38′ to 142° 7′	14° 29′	14,51 to 10,11	−0,3039
		0° 22′ to 142° 7′	141° 45′		
Lat. 40°	Mediterranean	−0° 23′ to 28° 59′	29° 22′	4,69 to 5,86	+0,0398
	Intermediate	28° 59′ to 52° 59′	24° 0′	5,86 to 8,17	+0,0962
	Continental	52° 59′ to 116° 28′	63° 29′	8,17 to 10,03	+0,0293
	Pacific	116° 28′ to 141° 59′	25° 31′	10,03 to 6,97	−0,1199
		−0° 23′ to 141° 59′	142° 22′		

IN PARALLELS THROUGH NORTH-AMERICA.

	Gradient	Range in degrees of long.		MV	Ratio to 1° long. + increasing — decreasing
Lat. 50°	Atlantic	64° 20′ to 91° 40′	27° 20′	8,22 to 12,78	+0,1668
	Continental	91° 40′ to 103° 42′	12° 2′	12,78 to 12,51	−0,0225
	Pacific	103° 42′ to 121° 46′	18° 4′	12,51 to 8,14	−0,2420
		64° 20′ to 121° 46′	57° 26′		
Lat. 41°	Atlantic	72° 5′ to 95° 56′	23° 51′	7,69 to 9,54	+0,0776
	Continental	95° 56′ to 100° 45′	4° 49′	9,54 to 9,27	−0,0580
	Pacific	100° 45′ to 122° 15′	21° 30′	9,27 to 6,29	−0,1388
		72° 5′ to 122° 15′	50° 10′		

IN A PARALLEL THROUGH THE SCANDINAVIAN PENINSULA.

	Gradient	Range in degrees of long.		MV	Ratio to 1° long. + increasing — decreasing
Lat. 62°	Atlantic	6° 9′ to 9° 8′	2° 59′	4,03 to 7,00	+1,0000
	Continental	9° 8′ to 13° 42′	4° 34′	7,00 to 8,33	+0,2932
	Baltic	13° 42′ to 17° 58′	4° 16′	8,33 to 7,11	−0,2857
		6° 9′ to 17° 58′	11° 49′		

Axel E. Aamodt, Kjøbenhavn.

30.–

PHYSICO-GEOGRAPHICAL MAPS

Prepared for eventual addition of signatures and notices concerning

METEOROLOGY, HYDROGRAPHY AND NAVIGATION

by

AXEL STAGGEMEIER
Lieut. colonel

Species	N° of Map	ZONES		LATITUDE	LONGITUDE from Greenwich
GENERAL MAPS	I	Northern zone		30° N — 90° N	0° — 0°
	II	Middle-zone	Atlantic face	45° N — 45° S	20° E — 100° W
	III		Pacific face	45° N — 45° S	100° W — 140° E
	IV		Indian face	45° N — 45° S	140° E — 20° E
	V	Southern zone		30° S — 90° S	0° — 0°
SUBDIVISIONS drawn on double the scale	VI	Northern zone		30° N — 90° N	60° E — 30° W
	VII				30° W — 120° W
	VIII				120° W — 150° E
	IX				150° E — 60° E
	X	Middle-zone	Atlantic face	0° — 45° N	20° E — 40° W
	XI			0° — 45° S	20° E — 40° W
	XII			0° — 45° N	40° W — 100° W
	XIII			0° — 45° S	40° W — 100° W
	XIV		Pacific face	0° — 45° N	100° W — 160° W
	XV			0° — 45° S	100° W — 160° W
	XVI			0° — 45° N	160° W — 140° E
	XVII			0° — 45° S	160° W — 140° E
	XVIII		Indian face	0° — 45° N	140° E — 80° E
	XIX			0° — 45° S	140° E — 80° E
	XX			0° — 45° N	80° E — 20° E
	XXI			0° — 45° S	80° E — 20° E
	XXII	Southern zone		30° S — 90° S	60° E — 30° W
	XXIII				30° W — 120° W
	XXIV				120° W — 150° E
	XXV				150° E — 60° E

Please address eventual demands for these maps to **Axel Staggemeier,**
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1897

BSB Bayerische StaatsBibliothek

MDZ Münchener DigitalisierungsZentrum Digitale Bibliothek

Madsen, Chr. Ludv.

Thermo-geographical Studies General exposition of the analytical method applied to researches on temperature and climate. Awarded by the Smithsonian institution, Washington, with the Hodg-Kings medal 1895. With numerous tables and plans and a codification of the principal thermo-geographical formulae, tables and definitions. Published at the expenses

Copenhagen 1897

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